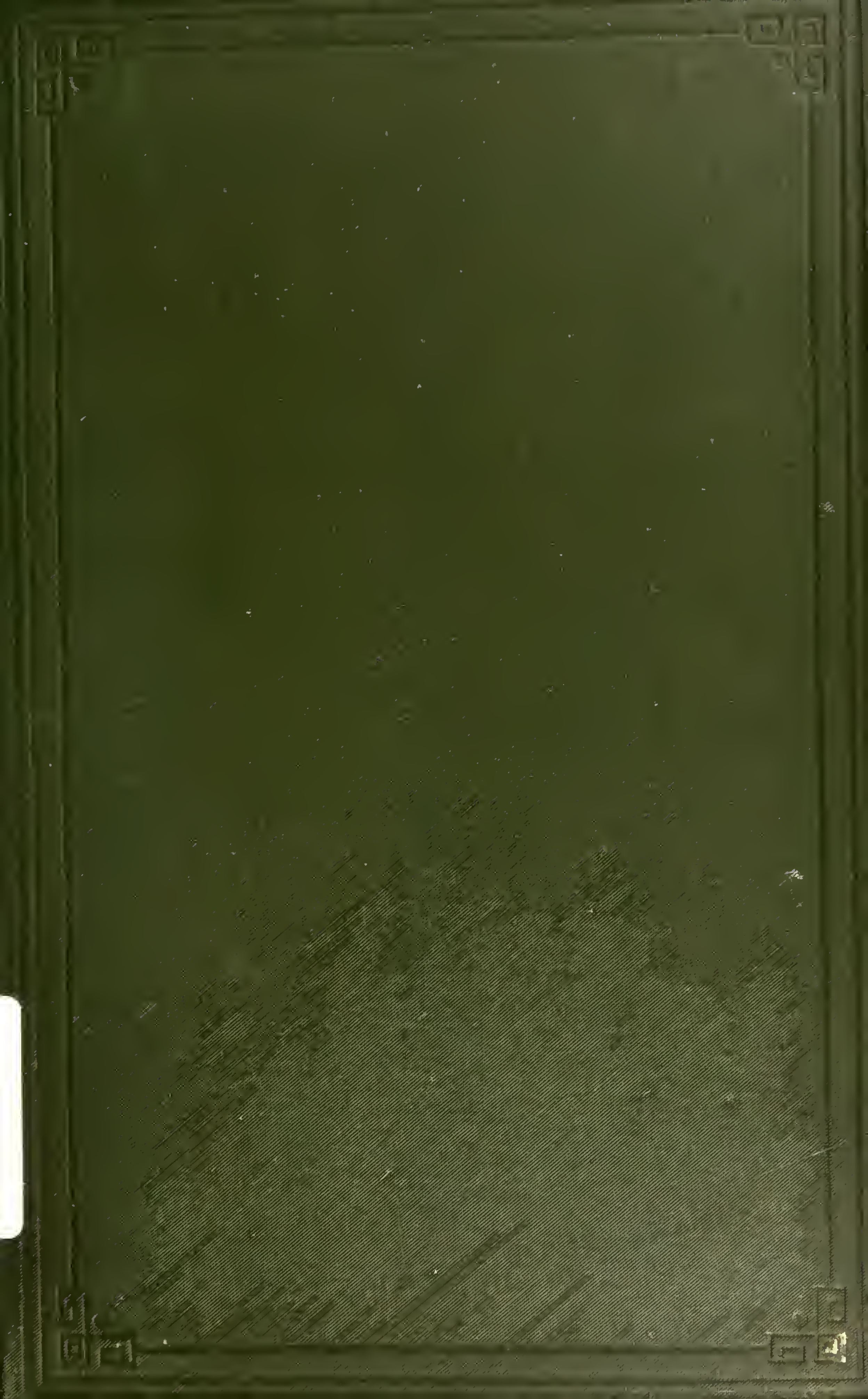

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ILLUSTRATIONS

OF

COMPARATIVE ANATOMY,

VERTEBRATE AND INVERTEBRATE,

FOR THE USE OF STUDENTS IN THE MUSEUM OF
ZOOLOGY AND COMPARATIVE ANATOMY.

SECOND EDITION.

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PREFACE.

THE specimens and dissections described in the following pages have been prepared to illustrate the most important forms in Invertebrate and Vertebrate Anatomy.

When the first edition of these descriptions, entitled 'List of Dissections,' was published in 1871, Invertebrate Anatomy alone was illustrated. We have now included four representative Vertebrate forms—Rat, Pigeon, Frog, and Perch: and have increased the series of Invertebrata from 55 to 90; adding to it several specimens, with detailed descriptions, of the Exoskeleton in those forms where such descriptions are not to be met with in the text-books that are commonly used by English students.

All the descriptions have been carefully revised. As in the former edition, we have not attempted to give a complete account of each dissection, but merely an indication of its leading features, to enable students more readily to recognise the points dwelt upon in the literature of the subject, or in lectures; and to shew them clearly the position and relation of the organs which they will subsequently have to examine when they begin to dissect. For this reason the very language used by Prof. Rolleston, Prof. Huxley, and others has been reproduced where it has been possible to do so. Our obligations to Prof. Rolleston are however far greater than mere passages of description, for it is to his work that our own owes its existence.

For the sake of brevity we have cited as 'Rolleston,' *Forms of Animal Life*, by G. ROLLESTON, M.D., Oxford, 1870.

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MUSEUM OF ZOOLOGY AND COMPARATIVE ANATOMY,
CAMBRIDGE, *May* 20, 1875.

ILLUSTRATIONS OF COMPARATIVE ANATOMY, VERTEBRATE AND INVERTEBRATE.

SUB-KINGDOM PROTOZOA.

1. A piece of the common Freshwater Sponge (*Spongilla fluviatilis*), exhibiting its siliceous skeleton.

Rolleston, p. 163.

SUB-KINGDOM CŒLENTERATA.

Class Hydrozoa.

2. A Sea-Fir (*Sertularia abietina*).

It consists of a slender pinnately-branched 'cœnosarc' invested by a chitinous 'periderm.' Both the main stem and the lateral pinnæ are beset by numerous sessile or sub-sessile more or less flask-shaped chitinous 'hydrothecæ,' in which the 'polypites' are lodged. In addition to these, larger but similarly shaped vesicles are to be observed studding the pinnæ. These are the 'gonothecæ' and contain the generative zooids. The animal when mature is non-locomotive and is attached to its base by a 'hydrorhiza.'

3. A Sea-Anemone (*Tealia crassicornis*), from which the base has been removed. The tentacles and the space round the mouth—'peristomial disc'—are too much retracted to be well seen. On the other side of the preparation the internal surface of the digestive cavity is exposed, marked with fine radiating lines, which correspond with the attachments to it of the vertical muscular lamellar plates termed 'mesenteries.' These

radiate from the outer surface of the stomach to the inner wall of the outer integument, and thus divide the space between the two—the body cavity—into a number of wedge-shaped compartments. Some of these 'mesenteries' fail by greater or less intervals to reach the outer surface of the stomach, and are therefore called 'secondary' or 'tertiary' mesenteries, while those that are attached to that organ and to the outer integument are called 'primary.' Between them are seen some of the generative glands. The cord-like 'craspeda' are also to be seen, attached to the inner edges of the mesenteries.

Rolleston, p. 158.

SUB-KINGDOM ECHINODERMATA.

4. A Common Cross-Fish (*Asterias rubens*).

The animal consists of a discoid body, produced horizontally into five radial prolongations. The ventral surface of the disk is depressed into a cavity having a pentagonal outline, and which is further continuous with the mesial lanceolate grooves extending along the ventral surfaces of each ray. The dorsal surfaces of the disk and rays, on the other hand, are convex and not grooved. In the middle of the ventral surface of the disk is the mouth: and on the corresponding part of the dorsal surface, the anus. Protruding from the radial grooves or avenues are the cæcal tube-feet: arranged in four rows, two on either side of a line running down the centre of each ray. There are two sets of spines bounding each avenue, 'one of which is placed internally and consists of two rows of long and slender spines: while the more externally placed is made up of three rows of shorter and blunter spines.' Externally to the latter is a third series of spines, marking the line of junction of the dorsal and lateral surfaces. Furthermore the dorsal surface of both rays and disk is studded with variously shaped spines, some short and obtuse, while others carry a small bunch of calcified setæ at their free extremities. None of the spines are moveable. On the extreme edge of the dorsal surface of the disk, and in one of the inter-radial spaces, there is a porous elevation—the madreporic tubercle—through the medium of which, and of the 'sand canal' with which it is in relation internally, the sea-water finds its way to the circular water-vascular canal surrounding the œsophagus. The tube-feet being restricted to the ventral surface of the rays and disk, that surface is distinguished by the term 'ambulacral' from the dorsal and lateral surfaces, which do not possess tube-feet, and are therefore called ant-ambulacral. Though the radial symmetry of the disk and arms is apparently very evident, yet the animal is really bilaterally symmetrical, thus:—the madreporic tubercle is inter-radial, and as both mouth and anus are central, a vertical plane drawn through tubercle, mouth and anus, will divide the animal into two symmetrical halves, each half including two rays and one half of the bisected ray. The two rays between which the madreporic tubercle lies are distinguished as the 'bivium,' while the remaining rays constitute the 'trivium.'

5. Another specimen, to shew the structure of the investing coriaceous test, and the disposition of the ossicles composing it.

The whole of the disk, with the exception of that portion on which the madreporic tubercle is situated, has been removed:—and, with a single exception, the cavity of each ray has been laid open by a longitudinal incision on the ant-ambulacral surface. Four rays have been divided transversely. Each ray consists of a solid axis and of the calcified arch supported by it. The axis itself is composed of a longitudinal series of ossicles, apposed to each other after the manner of vertebræ, and forming a solid though flexible rod extending along the ventral surface of each ray from the mouth to the tip. Each ossicle is double—that is, it is composed of two lateral halves, closely applied in the mesial line, and retained in position partly by a tendinous investment—and partly also by the longitudinal muscular fibres, which, in the fresh condition, pass from ossicle to ossicle. Each lateral ossicle gives off from its outer side a transverse process, which is slightly sinuous, or emarginate on opposite sides: so that by the apposition of the concavities of contiguous processes two alternating rows of foramina for the exit of the tube-feet are formed on each side of the median ossicles. The external extremity of each of the transverse processes abuts upon a small ad-ambulacral ossicle, which in addition to contributing to form the prominent margin of the ambulacral groove, and to supporting the innermost row of slender spines described in the preceding preparation, also marks the junction of the ambulacral and ant-ambulacral areas. The ad-ambulacral ossicle is best seen in the transverse section. Externally to the ad-ambulacral ossicles is a series of stout, rib-like rods, fewer in number than the transverse processes, as there is but one of the former to three of the latter. These form the lateral boundaries of the ad-ambulacral region. These 'ribs' are connected with each other by at least two well-marked rows of cross-bars on each side; extending from one 'rib' to the other. The 'rib' is not a single ossicle, but composed of several pieces joined together by oblique surfaces: so as to admit of some amount of sliding motion upon one another, in order to allow the consequent dilatation or contraction of the cavity, the walls of which they contribute to form. Towards the dorsal region, or roof of the ray, the 'rib' breaks up, and the pieces cross in all directions, forming an irregular network of ossicles imbedded in the thick integument. The first axial ossicle in each ray is much larger than the rest: and by their abutment upon each other a strong calcified ring is formed, encircling the mouth. The skeleton of the disk in no way differs from the structure of the rays: as it is in fact formed by the confluence of the ant-ambulacral integument of the five rays: and the axial ossicles themselves with their transverse processes are continued to the margin of the mouth, and only then abut upon each other. In the fresh state the radial ambulacral canal would lie in the ambulacral groove immediately beneath the axial series of ossicles, and still more superficially the radial nerve-cord:—while in the cavity of the ray the digestive and generative systems are contained. In the peristomial depression, and external to the calcified oral ring, the pentagonal nerve-collar would lie. It will thus be seen that from its relation to the nervous system and the radial ambulacral canals, the skeleton is really an internal one, and does not correspond to the ambulacral and inter-ambulacral plates of the *Echinus,* which form a true exoskeleton.

6. A Common Cross-Fish (*Asterias rubens*), dissected to shew its digestive system.

The whole of the integument has been removed from the upper or anal surface. In the centre is the membranous stomach, which has been stained pink, as also have been the five cæcal tubes—'diverticula'—radiating from it. A portion of the integument has been preserved round the anus, into which a black bristle has been inserted. From the intestiniform portion of the digestive tract arise some tufted cæcal appendages. The tubes which are given off from the stomach in the direction of each of the rays very soon divide into two, each of which gives off a number of arborescent cæca, filling up the whole cavity of each ray. At the base of each ray is placed a pair of generative glands. Each gland is made up of numerous cæca, converging to a duct opening at the base of the ray. The madreporic tubercle is between the first and second rays on the right of the preparation, counting from the top. In each ray, and on each side of the median longitudinal ossicles, may be seen numerous 'ampullæ.'

Rolleston, pp. 141—145.

7. A Common Cross-Fish (*Asterias rubens*), dissected to shew its generative system.

The dorsal portion of the integument, with the whole of the digestive apparatus, has been removed. The generative organs, ovaries or testes (the Echinodermata being 'diœcious'), are seen to consist of bundles of arborescent cæca, two to each ray, each bundle being attached at the base of the cavity which contains the digestive cæca, one on each side of the median longitudinal ossicles. The attached extremity of each gland indicates the position of its duct, which opens at the base of each ray in the inter-radial space.

8. A Common Cross-Fish (*Asterias rubens*), dissected to shew its nervous system.

The tube-feet have been removed. The nervous system lies on the ventral surface of the animal, and consists of a pentagonal ganglionated ring surrounding the mouth, from which a single cord passes down the centre of each ray.

9. A crinoid Echinoderm (*Pentacrinus caput-medusæ*), dredged off Barbadoes, 1869.

10. A Sea-Urchin (*Echinus sphæra*), divested of its spines, and dried.

The exo-skeleton is an immovably articulated, inflexible shell, composed of numerous—upwards of six hundred—calcified pieces, arranged in a definite pattern. The shape of the test is that of a sphere with flattened poles. One pole however, the oral one, is much more flattened than the other,—the anal one. With the exception of small circum-anal and circum-oral areas the remainder of the body, 'corona' as it is called, is composed of numerous calcified plates, disposed in twenty longitudinal series. These are furthermore arranged in ten double rows, radiating from one pole to the other. The five double rows of plates, which are perforated by the external apertures of small canals, constitute the ambulacra, while the remaining five double rows, alternating with the foregoing, and imperforate, form the inter-ambulacra. The ambulacral and inter-ambulacral plates in converging towards the poles of the shell become much smaller, and do not quite reach the poles, but leave small areas round the mouth and anus, in which the calcified plates have a different arrangement.

In the neighbourhood of the anus this space is occupied by two concentric rows of plates, the anal plates. The much larger circum-oral space—the 'peristoma'—is in the fresh specimen filled up by a leathery membrane strengthened by irregularly shaped calcified plates, in the centre of which is the mouth. Each ambulacral row of plates is separated from the adjacent row of inter-ambulacral plates by a tolerably straight but not very well defined suture. On the other hand the suture separating the two rows which together make up an ambulacrum or an inter-ambulacrum is a zigzag one: being formed by the alternation of the triangular internal extremities of the component plates. There is consequently such a suture running down the middle of each ambulacrum and inter-ambulacrum. The plates composing an ambulacrum are pentagonal, and transversely elongate. Each is perforated by six obliquely disposed apertures or pores, affording a passage to the tube-feet: and each carries on its surface conical tubercles varying in size. Furthermore each plate is subdivided by faintly visible oblique transverse sutures into three primary divisions or pore-plates, each pore-plate containing a pair of obliquely set pores: and the whole six apertures are situated close to the outer or inter-ambulacral edge of the plate. 'There is therefore a pore-plate or subdivision of the ambulacral plate corresponding to each pair of pores: and this arrangement would appear to hold good for all the *Echinoidea* except the *Clypeasteridæ*, where the pores of the locomotive feet are grouped together on a single plate.' (Huxley.)

Each row of ambulacral plates carries two rows of alternating conical tubercles, and in addition there are inner tubercles of various sizes scattered between the larger ones: these tubercles carry the spines, which beset the external surface of the skeleton.

The inter-ambulacral plates, though similar in shape, and carrying tubercles, are larger in size than the ambulacral, and imperforate. If an ambulacrum be traced upwards towards the apical pole of the shell, it will be found to abut upon one of the five smaller ossicles which form the outer row of circum-anal plates. Each of these angular plates is perforated, and supports an eye-spot. Hence they are called 'ocular plates.' The apical extremities of the inter-ambulacra are similarly related to the larger plates which form the inner series of circum-anal ossicles, and alternate with the ocular plates. These plates, of the inner row, are likewise perforated with a small aperture for the passage outwards of the generative products. Hence they have been termed 'genital plates.' One of these is much larger than any of the others, and is marked by a porous elevation, the madreporic tubercle: which internally is in relation with the sand canal.

The small area within the ocular and genital plates is occupied by small calcified tubercles and granules, within which the anus is situated. The growth of the shell in the *Echinidæ* is effected in two ways: partly by addition to the circumference of existing plates, and partly by the interposition of new ambulacral and inter-ambulacral plates at the apical end of each series. The tubercles which cover the plates terminate in rounded, ball-like summits, either simple, or marked by a small pit. The spines articulating with these tubercles have a cup-shaped depression at their attached extremity, which receives the rounded end of the tubercle in such a manner as to form a ball and socket joint. The spine is attached to the tubercle partly by a ligament which passes from the bottom of its articular surface to the pit in the tubercle: and partly by the muscular fibres which connect the neck of the spine with the base of the tubercle, and in addition produce all the motion of which these organs are capable.

It will be noticed that in addition to the absence of any lateral prolongation of the body into rays, an Echinus differs from a Starfish in the enormous development of the ambulacral at the expense of the ant-ambulacral region: so that the latter eventually becomes reduced to a very small space round the apex. As in the Starfish, the test is bilaterally symmetrical, for on each side of the vertical plane in which the mouth, anus, and madreporic tubercle lie, there are two and a half ambulacra, and two and a half inter-ambulacra. The disposition of the ambulacra into bivium and trivium is also obvious.

11. Two Sea-Urchins (*Echinus sphæra*), with the spines and tube-feet intact.

The spines cover the whole of the ambulacra and ant-ambulacra. They fail however to be developed for some little distance round the mouth, though they extend up to, and even arch over, the anus. Though they vary much in size, they are all of one shape. Each spine is cylindriform, striated longitudinally as well as transversely, and tapers gradually towards its apex, which is tipped with purple. The spines that form a continuous series from one end to the other of an ambulacrum or inter-ambulacrum are distinguished as 'primary' spines, while the smaller and less regularly arranged are, in proportion to their size, termed 'secondary' or 'tertiary.' The five pairs of rows of tube-feet are to be seen protruding from the pores. Each foot is a tubular cæcal process, terminating distally in a slightly expanded, disk-like extremity:—while internally it is in connection with the 'ampullæ' and one of the 'radial trunks' of the water-vascular system. In the peristomial area, and immediately surrounding the mouth, the tube-feet become modified into a circle of more or less plumose appendages, which may be regarded as the aborted rudiments of the tentacular crown of the *Holothuroidea*.

12. A Sea-Urchin (*E. brevispinosus*), bisected horizontally, to shew the internal surface of the shell.

The ambulacral plates are produced into five short truncated processes, so perforated as to form five small vertical arches, which arch over the ambulacra, and are called 'auriculæ.' Through these apertures the radial nerve-cords and the radial canals of the water-vascular system pass from the nerve-collars and water-vascular ring. From the relation which these 'auriculæ' bear to the nervous and water-vascular systems it would seem as though they represented the ambulacral ossicles of the Starfishes.

13. A *Clypeaster* bisected to shew the great development of the 'auriculæ,' which here are so large as to unite the oral and apical walls of the 'corona.'

14. A Spatangus (*S. purpureus*), bisected to shew the total absence of 'auriculæ.'

15. A Sea-Urchin (*Echinus sphæra*), prepared to shew its generative and digestive systems.

The test has been horizontally bisected, and the apical half of the shell suspended above the oral half.

The œsophagus, as it emerges from the arrangement of calcified jaws called Aristotle's lantern, to be described in the next specimen, is of moderate calibre, but subsequently it somewhat abruptly expands into a large and thin-walled intestine, which, after turning twice round the inside of the test, passes along an inter-ambulacral space to the anus. At the commencement of its second and superior convolution round the shell it bends upon itself and runs in an opposite direction to its first circuit, to which however it still remains parallel. The two convolutions are attached by a much-fenestrated mesentery to the inside of the test, and are disposed in festoons. Two pseud-hæmal vessels can be seen in relation with the intestine, one running along its inner, and the other along its outer or mesenteric border.

The ovaries are five in number, and are arranged round the apical area, one in each of the five inter-ambulacral spaces. A short tubular oviduct conveys the ova to the apertures before described as existing in the five genital plates.

The ampullæ are seen on the internal surface of the shell in the ambulacral areas; and mesially between each of the two rows of ampullæ in an ambulacral area one of the five radial nerve-cords can be seen.

Rolleston, p. cl.

16. The oral skeleton, whole and separated into its component parts.

17. The lower half of an Echinus (*E. sphæra*), prepared to shew the mouth, and the muscles that move the jaws.

"The apparatus consists of five hollow wedge-shaped calcareous pieces, the 'alveoli,' each of which is composed of two halves united together in the mesial line, while each half again consists of a superior epiphysis and an inferior principal portion. Each 'alveolus' serves as the socket to a long tooth shaped like the incisor of a rodent, harder externally than internally, so as always to develop a sharp edge with wear, and constantly growing from its upper extremity. The five alveoli, fitted together, form a cone, whose applied surfaces are united by strong transverse muscular fibres, while superiorly the epiphyses of each pair of alveoli are connected by long radial pieces, the 'rotulæ.' To the inner extremity of each 'rotula' finally a slender arcuated rod presenting indications of a division in the middle of its length is articulated, and running outwards parallel to the 'rotula' terminates in a free bifurcated extremity. This is the 'radius' or 'compass' of Valentin. Altogether the 'lantern' consists of twenty principal pieces, five teeth, five 'alveoli,' five 'rotulæ,' or 'falces,' and five 'radii' or 'compasses:' of which the alveoli are again divisible into four pieces each, and the radii into two: making a total of forty pieces. In their normal position it must be remembered that the alveoli and teeth are inter-ambulacral, while the 'radii' and 'rotulæ' are ambulacral. Besides the inter-alveolar muscles this complex apparatus has protractor muscles arising from the inter-ambulacral region of the oral edge of the 'corona,' and inserted into the upper part of the alveoli; slender oblique muscles, with a similar origin, but inserted into the radii; transverse muscles connecting the radii together; and retractor muscles arising from the arches of the 'auriculæ,' and inserted into the oral ends of the 'alveoli.'"

Huxley, *Medical Times and Gazette,* 1856, vol. xiii. p. 587.

The next three preparations illustrate the anatomy of the *Holothuroidea.* In each a *blue* rod has been placed in the mouth: a *red* rod in the anus.

18. A Great Sea-Cucumber (*Cucumaria frondosa*), verti-

cally laid open. In this specimen the animal has contracted so much, that the whole of the tract round the mouth—'the peristomial space,'—with the tentacles, has been withdrawn within the body-walls, and hangs down like a bag, which has been laid open so as to expose the tentacles, of a black colour.

Five pairs of longitudinal muscular bands, radiating from mouth to anus, are seen to divide the body-walls into a corresponding number of crescent-shaped divisions, in which the muscular fibres, which encircle the animal transversely, are well seen. In the interval between the two elements of each pair of muscular bands lies the longitudinal water-vascular ambulacral vessel. In this family—the *Dendrochirotæ*—each longitudinal muscle gives off a long slip which inserts itself into the corresponding radial ossicle of the calcareous ring encircling the mouth, and acts as a retractor. The water-vascular ring surrounds the muscular pharynx, a little way posteriorly to the calcareous ring. In the centre of the preparation are the muscular pharynx and stomach. On the exterior may be noticed the longitudinal rows of apertures for the tube-feet, which, however, are now partially retracted.

Rolleston, p. 145 sq., and p. cxlvii.

19. A specimen of *Psolus phantapus* with part of the dorsal and ventral surfaces removed. The animal is contracted as in the last preparation. The longitudinal and retractor muscles, and the calcareous ring with its two Polian vesicles, are well seen.

On the ventral side of the preparation is seen the whole of the digestive tract, spread out upon a sheet of mica. The anal end receives the ducts of the so-called respiratory trees, which in the preparation depend downwards from the cloaca, one on each side. These organs consist of hollow stems carrying somewhat scanty ramifications; they reach a considerable distance into the body, to the walls of which they are attached by mesenteries.

On the dorsal surface is the generative gland—a bundle of simple unbranched cæca of various lengths. The mesentery, by which it was attached to the body-walls, has been removed. A single efferent duct passes from these cæca to open inside the circle of oral tentacles, above the calcareous ring. The ventral surface is covered with calcareous scales, and is destitute of tube-feet: though these latter do exist in other parts of the body.

20. A specimen of *Holothuria tubulosa,* dissected to shew the generative system and 'respiratory tree.' The greater portion of the left side of the body has been removed, together with the whole of the digestive tract, except the pharynx and cloaca. These are well displayed, as also are the mesenteric bands by which the cloaca is attached to the body-walls.

The generative cæca have been spread out on a piece of mica. They are disposed in two groups, but are shorter and much less subdivided than in *Psolus,* and end in dilated cæca. The two ducts, one from each group, shortly unite to form the common efferent duct, appended to which, at about the level of the calcareous ring, is a number of minute pyriform vesicles. The external opening of the generative duct has a black bristle inserted into it. The respiratory tree consists of a hollow stem extending from the cloaca, with which it is in communication, as far forwards as the pharynx. Numerous filiform and arborescent cæcal appendages are given off from it. The mesenteric fibres by which the stem is attached to the body-wall are well seen.

On the left of the preparation is the 'respiratory tree,' attached by mesentery to the body-wall. A green rod has been inserted into the orifice by which it opens into the 'cloaca.' Depending from the calcareous ring are the 'ampullæ' of the water-vascular ring surrounding the mouth.

SUB-KINGDOM VERMES.

Division Annulata.

Class I. Annulata proper.

21. An *Amphinome.* The body, though elongated, is of considerable transverse width, and is divided by numerous transverse constrictions into about 60 segments. With the

exception of the cephalic the whole of the segments differ from each other in little else than their comparative calibre. The integument is not hardened by the deposition of chitinous or calcareous matter, and the appendages attached to the different 'somites' are soft, and devoid of segments or of joints. A typical 'somite,' from the middle region of the body, may be said to consist of dorsal and ventral arcs—each arc terminates on each side in a conical eminence, constituting with its appendages ('cirri' and 'setæ') a 'notopodium' or 'neuropodium' according to the arc with which it is in relation. The appendages attached to the 'notopodium' are; first, a tuft of branching cæca dorsally placed; secondly, a fasciculus of chitinous setæ; thirdly, a small 'cirrus.' The neuropodial appendages are separated from the notopodial by a well-marked interspace, and consist of, (1) a small fasciculus of setæ, and (2) a cirrus: but no branchiæ. Towards the head and anal extremity the branchiæ become very small and are absent altogether on the first two post-cephalic segments: and the setæ are also insignificant in size. The mouth and anus are terminal: the former is situated on the ventral surface of the third somite.

22. A Common Earthworm (*Lumbricus terrestris*), dissected to shew its digestive system.

The transversely annulated integument has been divided down the medio-dorsal line and pinned out on either side. The digestive tract is seen in the middle line of the preparation, and extends, without any convolutions, direct from mouth to anus.

The mouth (formed by a modification of the first segment) leads into an oval pharynx, whose external surface has a coarsely villous appearance, due to the breaking away of the delicate muscular bands by which it was attached to the body-wall. The œsophagus, in length about five-eighths of an inch, and of much smaller calibre, leads from the pharynx to the large and globular crop. Immediately succeeding this latter cavity, and of slightly smaller size, and lighter colour, is the so-called gizzard. Posteriorly to the gizzard the intestine is continued as a slightly sacculated tube of even diameter to the anus. Attached to the œsophagus immediately anterior to the crop are three pairs of minute glands of unknown function called œsophageal glands.

The membranous partitions extending from the body-wall to the alimentary canal, and dividing the perivisceral cavity into a series of inter-communicating spaces, are well seen in the middle third of the preparation. In the inter-mesenteric spaces of the middle third of the body are to be seen the 'segmental organs,' consisting in each space of a looped internally ciliated tube, communicating by its internal extremity with the perivisceral cavity, and by its other extremity opening externally.

Rolleston, p. 119.

23. The same, dissected to shew its nervous system.

The integument, divided in the medio-dorsal line, has been pinned out on either side, and the whole of the digestive and generative systems removed. The nervous tract is seen occupying the medio-ventral line, and extending from the oral to the anal extremity of the body. The supra-œsophageal mass is seen to consist of two pear-shaped lobes applied together in the median line by their broad ends, their apices pointing outwards. From the outer end of each of these two lobes a large nerve passes forwards to supply the upper lip, and a bristle has been placed underneath them. A commissural cord on each side proceeds downwards from the supra-œsophageal ganglia, encircling the œsophagus and connecting these ganglia with the ventral nervous cord.

The anterior portion of the cord is of considerable thickness, and, on close inspection, may be seen to be composed of two distinct strands; the ganglionic enlargements are, however, with difficulty recognizable. In the middle third of the body the cord becomes much thinner, but assumes a beaded appearance owing to the greater comparative size of the ganglia and the wider interspaces which separate them. In the posterior third of the body it again becomes of considerable size, but the ganglia are less distinctly visible and more closely apposed.

A pair of nerves is given off from each pair of ganglia, and a single nerve on each side from the segments of the cord interposed between each pair of ganglia.

24. A Sea-Mouse (*Aphrodite aculeata*), dissected to shew its digestive organs.

The animal has been laid open along the ventral surface, the nervous system having been removed.

The mouth, into which a black bristle has been inserted, leads into a thick, cylindrical, muscular sac, called by some a gizzard. The posterior extremity of this opens by a narrow, sigmoid segment, into a funnel-shaped stomach, which gradually diminishes in size, and insensibly passes into an intestine, terminating at the anus. Throughout the whole length of the stomach, cæcal processes are given off on each side to the number of about twenty pairs. They are slender at their origin, but gradually enlarge, and give off lateral 'diverticula,' which again, in their turn, divide and subdivide, terminating finally in fusiform dilatations. These cæca are probably homologous with the gastric cæca of the leech; and the so-called 'gizzard,' which is capable of protrusion, has been considered to be homologous with the projectile proboscis of other Annelids.

The stomach has been filled with red injection, and the cæca partially so. They have been dissected and pinned out on the left side. On the right they remain *in situ*, lying among the transverse muscles. On this side also may be seen the delicate muscular bands, which pass from the base of the bundles of setæ to the integument, and effect their protrusion.

25. The same, dissected to shew the 'elytra.'

A longitudinal strip of the dorsal coating of 'felt' has been removed and the 'elytra' displayed.

The 'elytra' are broad membranous plates developed as appendages from the notopodia, and, arching inwards over the back, form two lateral series on either side of the medio-dorsal line. Beneath the elytra is the membranous partition forming the dorsal boundary of the visceral cavity. The nervous system may be seen on the ventral surface of the body, through the integument.

It is to be observed that the 'Sea Mouse' is much less distinctly annulated than the Earthworm: and that the 'setæ,' which in the Earthworm are almost microscopic, are here of large size and iridescent.

26. A Leech (*Hirudo medicinalis*), dissected to shew its nervous and generative systems.

The nervous system consists of a longitudinal ganglionated ventral cord containing about twenty-four ganglia, from which delicate nerves radiate on either side. The ganglia are more approximated at both ends than at the middle of the animal. From the foremost, or sub-œsophageal, ganglion pass the nerves to the oral muscles and the cords on either side of the œsophagus. These, meeting above, join the super-œsophageal ganglion from which radiate nerves to the ten ocelli and other parts of the head.

The testes are nine spherical bodies on either side of the nervous cord connected by their ducts with a common canal, or 'vas deferens,' which runs external to them and communicates in front with a receptacle or 'vas deferens.' The two receptacles are connected with the muscular ball from which the penis is continued. The ovaries, smaller than the testes, are situated, one on either side, just behind the 'receptacula seminis,' and are connected by short oviducts with the muscular bag or vagina.

Division Annuloida.

Class II. Nematelminthes.

27. The generative organs of a male and female *Ascaris* (*Ascaris lumbricoides*, L.), taken from the duodenum of a young woman. The male, on the left, is smaller than the female. It—the male—has been opened longitudinally, and the intestine, a straight tube, is seen passing from the mouth to the anus. It has been pinned somewhat to the left of the specimen. The testis is a long curling tube, very attenuated at its commencement. It gradually becomes thicker, and is disposed in numerous coils round the alimentary canal. About three inches from its termination it suddenly dilates into a larger tube or receptacle, which, narrowing again, is continued to the posterior extremity of the animal. Its lowest part, beneath which a slip of blue paper has been placed, admits of protrusion, and is called the penis.

The female has also been laid open longitudinally. The intestine, like that of the male, is a straight tube, extending the whole length of the animal, but it expands much more near its anal end. The ovarian tubes commence as thin filiform cæca arranged in complicated coils round the intestine. Near the anus however these tubes become suddenly expanded, and extend as far forwards as the anterior third of the body: where they unite to form a short and very narrow oviduct, which opens outwards. This, turning round the intestine and becoming narrow, terminates at the genital aperture one-third from the anterior end of the animal.

Class III. PLATYELMINTHES.

28. A Tape-Worm (*Tænia solium*).

The specimen, a mature worm (*Strobilia*), is a flattened, ribbon-shaped organism, divided by transverse constrictions into numerous well-defined segments—the 'proglottides,'—which are for the most part of large size, but on approaching the head they become gradually smaller, and the constrictions less evident, till in the vicinity of the head the body becomes reduced to a mere flattened thread, and the constrictions are only represented by faintly marked 'striæ.' A short, smooth, faintly-striated neck is succeeded by the head. This is about the size of a pin's head, and is armed with a double circlet of minute spines, and carries in addition four minute suckers. The 'proglottides' in the hinder part of the specimen are of a whitish colour, opaque, and three or four times as long as they are broad. The head, 'nurse,' or 'scolex,' is asexual. The segments succeeding are sexual, but immature: that is, their generative organs and their products are but imperfectly developed. The segments which succeed and make up the bulk of the organism, are sexually mature, hermaphrodite 'proglottides.' The new segments are produced by a process of gemmation from the head: and the segments thus produced are intercalated between the head and the segments already formed. The apertures of the efferent ducts of the male and female organs are situated on small cup-shaped eminences placed on the lateral margins of the 'proglottides,' the side alternating in adjoining segments. The specimen is eight feet in length, and was taken from a human intestine.

SUB-KINGDOM ARTHROPODA.

Division TRACHEATA.

Class MYRIAPODA.

29. A Centipede, *Scolopendra*, a Chilopodous Myriapod.

The segments of the exo-skeleton differ from those of Insecta and Crustacea in not being definitely marked out into cephalo-thoracic, abdominal, and post-abdominal regions. There are twenty-three post-cephalic segments, to each of which a single pair of appendages is attached. Any one of these appendages consists of a dorsal and ventral arc, united together laterally by the soft integument from which the appendages take origin. On either side of the mesial line of the ventral arc are two very faint lines, which mark off a median portion, or 'sternum,' from two lateral elements, or 'episterna.' These faint lines are best seen in the sterna of the anterior segments. Imbedded in the lateral integument are one or two chitinous plates or tubercles, representing the rudimentary 'epimera' or lateral elements of a typical 'somite.' Each appendage is many-jointed. The proximal joint is the 'coxa,' and the distal one carries a sharp curved claw. Each segment is to be regarded as being composed of two sub-segments, which at first are equally developed, but as development proceeds, one of them increases in size more rapidly than the other; and moreover develops a pair of appendages which the other does not. This latter, the anterior one, becomes abortive, though in the Chilognatha it develops equally with the posterior one, with which it eventually coalesces, and moreover carries a pair of appendages. Nevertheless in this specimen the remains of the anterior sub-segment are to be seen. Immediately in front of each sternal piece, and on each side of the mesial line, are three small angular chitinous plates. The pair nearest the mesial line are the two uncoalesced halves of the sternum of the aborted anterior sub-segment. The pair external to these are the episterna, and the most external and smaller pair are the epimeral plates. Epimeral plates are also situated, one pair on the hinder edges of the sternum, and two small plates just in front of the coxa, imbedded in the lateral integument. The two sub-segments, one of which in Chilopoda is abortive, are equally developed in Chilognatha, and each carries a distinct appendage. The terga, however, are confluent, so that the double nature of each body-segment is only evident when the ventral surface is examined, where two pairs of appendages will be found attached to each segment. The segmental appendages are composed of six joints, coxa, tibia, femur, metatarsus, tarsus, and claw. The anterior appendages are the smallest, but they gradually increase in size posteriorly; and the hindermost pairs are directed backwards and not outwards, as is the case with the anterior ones. The last pair is very much larger than any of the rest, curves inwards, and by mutual apposition forms an efficient clasping apparatus. The anus opens on the under surface of the last segment. In several of the segments a pair of small, crescentic, laterally placed slits surrounded by prominent chitinous lips is to be seen a little inferior to the dorsal arc: these are the ‘stigmata.’

The head is probably formed by the fusion of at least five of the most anterior segments. The superior surface is formed by a broad, shield-like plate, quite smooth, and devoid of sutures, with the exception of a faint median groove. To the anterior margin of this plate is attached a pair of multiarticulate antennæ consisting of not fewer than seven segments. In this respect the Order Chilopoda, to which this species belongs, differs from the Order Chilognatha, in which the antennæ are composed of fewer than seven segments. At the base of the antennæ, and external to them, are four sessile ‘oculi.’ On the inferior surface of the head, in addition to the antennæ already described, the following appendages are to be seen. First, a pair of mandibles, toothed on their inner edges, and carrying small rudimentary palpi on their outer edge. Secondly, two pairs of maxillæ, of which the anterior pair is jointed, palpiform, and forms the external elements of the labium, while the posterior pair is composed of two small conical pieces applied together in the mesial line, but not united, and constituting the mesial part of the ‘labium.’

The appendages hitherto enumerated belong to the head, the remainder, proceeding backwards, to regions which in the Lobster are termed thoracic, abdominal and post-abdominal.

Succeeding the maxillæ is a pair of jointed appendages, armed with a small claw. The next are the large cheliform poison-fangs. These are armed with claws, and the extremity of each claw is perforated by the aperture of a small duct leading from a poison-gland. The basal joints are confluent, so that by this union a second labium is formed posterior to the first. The two last-mentioned appendages may be taken as corresponding to two of the three pairs of maxillipeds in the Lobster, and to the two anterior pairs of legs in Insects.

The segment to which the large 'chelæ' are attached is larger than the segment immediately succeeding it.

30. A Centipede (*Scolopendra*), dissected to shew the digestive and female generative systems.

The animal has been laid open along its dorsal surface, so as to expose the alimentary canal, which is simple, and passes in almost a straight course from mouth to anus, the terminal portion of the intestine alone indicating any approach to a convolution. It is distended with food. The stomach, which occupies the central third of the body, is the widest part of the canal: it communicates anteriorly with the mouth by a narrow œsophagus, and posteriorly is marked off from the intestine by a slight constriction. The intestine, at its junction with the stomach, though of less calibre than the latter, is yet of considerable size; but diminishes as it proceeds, and after describing a sigmoid flexure terminates in an anus.

The ovary is a long and simple tube, attached above to about the middle of the stomach, and gradually diminishing in size till it reaches its vaginal outlet. The ovi-sacs may be seen through its semi-transparent wall throughout its whole extent.

The white cæca pinned on either side of the lower part of the preparation are the 'accessory glands.'

31. A Centipede (*Scolopendra*), dissected to shew the male generative organs.

The animal has been laid open along its dorsal surface, and the digestive tract removed. The testes consist of a series of pairs of fusiform vesicles, each vesicle being applied along its whole length to its fellow, from which however it can be easily separated. They occupy a considerable portion of the abdomen, and extend forwards as far as the anterior fifth of the body. Each end of each vesicle communicates by a duct with a minute common longitudinal canal. There would thus be twenty pairs of ducts passing from the testes to the central canal. Posteriorly this canal becomes of considerable size, and is disposed in spiral coils before it reaches its external opening. Beneath it, and in the last two segments of the body, are seen the 'accessory glands.' The long dorsal vessel has been pinned on the left of the specimen.

32. A Centipede (*Scolopendra*), dissected to shew its nervous system.

It has been laid open along its ventral surface. A black bristle indicates the position of the œsophagus.

The nerve-system consists of a double cord placed medially in the body. The cephalic ganglion supplies the antennæ and eyes. Posteriorly to this the cords divide to admit of the passage of the œsophagus. Subsequently there are ganglia at regular intervals, corresponding in number to the segments of the body. From each nerves are given off to supply the legs. The first ganglion is oval in form, the others are round.

Class Insecta.

1. Order *Coleoptera*.

33. A Goliath Beetle (*Cetonia cacicus*), disarticulated and mounted on wires to shew its segments and their appendages.

34. Digestive system of an Oil-Beetle (*Meloe proscarabæus*).

Nearly the whole of the exoskeleton, together with the other organs, has been removed.

The œsophagus, which is very short, leads into a large elongated oval stomach, occupying the greater part of the abdominal cavity. On leaving the stomach the intestine becomes suddenly extremely narrow, and is slightly convoluted. Its terminal segment is dilated into a rectum.

Near the posterior end of the stomach the hepatic vessels, a number of thread-like cæcal tubules, may be seen.

35. A Stag Beetle (*Lucanus cervus*), dissected to shew its nervous system.

The supra-œsophageal mass consists, as usual, of two cephalic ganglia, from which are derived the nerves which supply the eyes. These ganglia are connected with the ventral cord by a double nervous cord encircling the œsophagus. Three large ganglia supply the thorax. The first pair of abdominal ganglia are very large, but the remaining six, with the exception of the last, are small. This ganglion sends off a bundle of nerves which supply the segments posterior to it.

36. A Common Cockchafer (*Melolontha vulgaris*), female, dissected to shew its generative and digestive systems, which have been arranged on the left and right sides of the tablet respectively.

Generative organs. Each ovary is composed of a single fasciculus of egg-bearing cæca. These cæca, or tubules, at their commencement are small and slender, but as they descend they dilate and assume a granular appearance, eventually fusing to form the oviduct. The cæca composing the right ovary have been partially separated. The two oviducts combine to form the common vaginal canal, which opens externally. On the right of the 'vagina,' and opening into it by a short duct, is the pyriform 'spermatheca:' on the same side and with the same termination is the glandular accessory cæcum.

Digestive system. This is seen to be a canal of great length in proportion to the size of the insect, of tolerably uniform diameter throughout, and much convoluted.

2. Order *Orthoptera.*

37. A Common Cock-Roach (*Periplaneta orientalis*), dissected to shew its digestive system.

The œsophagus opens into a large pear-shaped crop. On either side of the œsophagus may be seen the two-lobed salivary gland. Posterior to the crop, and separated from it by a slight constriction, is the muscular gizzard. The true chylific stomach which succeeds receives at its anterior extremity a whorl of eight cæca; and a cluster of much longer and more slender tubules is similarly arranged round its lower end. The first eight cæca are regarded as analogous to the liver of higher animals, while the tubules are probably renal. The 'colon,' which is connected with the stomach by a short segment of intestine, of small calibre, is large, and bent upon itself. The terminal portion, or 'rectum,' is marked by longitudinal muscular bands.

Rolleston, p. 86 and p. 199.

38. A Locust (*Locusta*), dissected to shew the female generative system and the digestive system.

The insect has been opened on its dorsal surface, most of which has been removed.

The ovigerous cæca form two bundles, one on each side. The tubules composing them unite to form an oviduct. The two oviducts join in the median line, and form the short and wide vaginal canal which opens externally at the base of the large ovipositor. Communicating with this canal by a short duct is the 'spermatheca' (pinned to the left side), and also a long thread-like accessory cæcum (pinned to the right side).

The digestive system of the insect has been arranged on the right of the preparation. It closely resembles that of the Cock-Roach; but the hepatic cæca are unusually large, and the renal tubes are small.

39. A Locust, dissected to shew the male generative organs.

The insect has been prepared in the same way as the last. The testes are two large oval compressed bundles of sperm-secreting tubules, one on each side of the body. Between them is a mass of accessory glands, which have taken the form of minute, much convoluted tubes.

3. Order *Diptera*.

40. A Common Flesh-Fly (*Sarcophaga carnaria*), dissected to shew its digestive and female generative organs.

The insect has been laid open along its dorsal surface.

The alimentary canal has been pinned to the right. It consists of a long tube, in which scarcely any difference between stomach and intestine can be observed. The ovaries are seen to be clusters of white cæca, arranged spirally. In this species the female is viviparous.

Packard on Insects, p. 408.

4. Order *Lepidoptera.*

41. Larva of Privet Hawk Moth (*Sphinx ligustri*).

Bristles have been inserted into the spiracles of the right side.

Rolleston, p. 73.

42. Pupa of the same.

43. Larva of the same, dissected to shew the nervous system.

It has been laid open on its superior surface, and the digestive system removed, with the exception of a piece of the œsophagus, which has been pinned back, in front of the head.

The nerve-system consists of twelve ganglia, arranged in a linear series along the ventral surface of the larva. The first pair of these are the cerebral ganglia, situated immediately above the œsophagus. They are connected by the usual nerve-collar, embracing the œsophagus, with the first post-oral ganglion. The terminal ganglion of the series is composed of two ganglia, closely opposed to each other, from which a leash of nerves is given off to the terminal segments of the body.

Rolleston, p. 82.

44. Larva of Goat Moth (*Cossus ligniperda*), dissected to shew the internal organs.

The integument has been divided down the medio-dorsal line and pinned out on each side.

Occupying the greater part of the body-cavity and investing the contained viscera is a mass of lobulated adipose tissue, known as the 'fat body' or 'rete,' which disappears almost completely in the 'imago' of those insects whose metamorphosis is complete.

In the median line is the digestive tract, which passes, without forming any convolutions, direct from mouth to anus. The walls of the œsophagus are thin, and thus readily distinguish it from the thick-walled, opaque, corrugated stomach.

A little way below the pylorus the intestine receives the common ducts of the tubular renal organs, the so-called 'Malpighian vessels.' The common duct on each side bifurcates, and the branches so formed extend anteriorly and form two loops on either side of the stomach; the trunk forming the outermost of the two loops in descending bifurcates again on each side. There are thus three trunks on each side of the stomach, forming an intricate plexus round the pylorus, and finally terminating blindly. The long, convoluted, and much larger tubes seen on each side of the digestive tract are the silk-glands; they commence blindly in the posterior part of the body, and terminate in a common duct opening on the modified 'labium' or 'spinneret.'

On the left side of the stomach is seen a thin-walled, transparent sac, the posterior end of which is connected with a much-convoluted tubular gland, which bends forwards, and in the preparation lies on the outer side and in advance of the sac. This sac is connected anteriorly with the mouth by a wide duct. The tubular gland, bladder, and duct correspond with the smaller salivary glands of the imago.

In the intervals of the fat body fasciculi of tracheæ are seen diverging to distribute themselves upon the viscera.

The following points in which the viscera of the larval form differ from those of the imago may be noticed in this preparation:—the presence of the 'fat body,' the larger calibre and lesser length of the digestive canal, and the absence of convolutions, and the presence and large size of the silk-glands.

Rolleston, p. 79.

Class ARACHNIDA.

45. A Scorpion (*Scorpio afer*), to shew the exo-skeleton.

The exo-skeleton presents a well-marked division into cephalo-thoracic, abdominal, and post-abdominal regions, and with the exception that the abdominal segments are here distinct from each other, these divisional areas approximate closely to the same parts in the lobster. The cephalo-thorax is a broad and but slightly convex plate marked by a median antero-posterior groove, and with a deeply emarginate anterior border. At the commencement of the posterior fourth of its extent there is a shallow transverse groove curving forwards on either side, dividing the cephalo-thorax into a large anterior and a much smaller posterior division, and bearing some resemblance to the cephalic suture, to be subsequently described, in the lobster. In the centre of the cephalo-thorax, and situated upon a little eminence, is the medio-dorsal pair of 'oculi,' one on each side of the median groove. There are also three additional 'oculi' at each antero-external angle, on each side of the anterior median notch.

The segmental appendages, of which there are six pairs, namely, counting from before backwards, antennæ, mandibles, and four pairs of ambulatory legs, are entirely confined to the cephalo-thorax. Functional antennæ are absent: but the homologues of the antennæ of Insecta are the large and strong cheliform appendages situated in front of the mouth, and so modified from their ordinary structure as to become efficient prehensile organs. The first post-oral pair, the mandibles, are in this species remarkable for the extraordinarily disproportionate development of the mandible proper and its 'palpus.' While the former is a small, internally flattened, slightly serrated plate, the latter, absent in Insects and with the exception of a rudiment, in Myriapods also, is enormously elongated, and carries huge 'chelæ' at its distal extremity. The two succeeding pairs of appendages correspond to the two pairs of 'maxillæ' in the lobster. In the first pair the 'maxillæ' themselves are small, somewhat conical, curved inwards, and form the external lateral elements of the 'labium.' The 'palpi,' on the contrary, are greatly elongated, six-jointed appendages, with two small claws attached to their distal segment. In the second pair a similar arrangement exists. The maxillæ are two triangular processes, applied by their straight internal edges to each other in the median line, and so forming the mesial elements of the 'labium.' The palpi resemble those of the first pair of maxillæ. The next two pairs of feet, representing the two pairs of 'maxillipeds' in the Lobster, and the two anterior pairs of legs in Insects, resemble the maxillary palpi just described, with the exception that they are longer, and have much larger basal segments.

The next segment, which in the Crustacea would carry the third pair of 'maxillipeds,' is, as in the Chilognathous Myriapods, the genital segment. In the centre of the sternal surface of this segment is the opening of the efferent duct of the reproductive organs. An opercular process, attached in front, and free posteriorly, hangs like a flap over this aperture. This may probably be regarded as the sternal element of this segment. The sternal elements of the two maxillary segments of the 'cephalo-thorax' are aborted, but in the two succeeding segments the sterna, though small, are still sufficiently obvious.

The segments and appendages hitherto described belong to the cephalo-thorax: the five succeeding ones to the abdominal region. The abdominal segments are distinct from each other, and, with the doubtful exception of the first, carry no appendages. Each consists of a broad tergal and sternal arc, united laterally by non-chitinous membrane. The sternal element of each segment is divided into a median division, 'sternum,' and two lateral divisions, 'episterna,' by two well-marked grooves, one on each side of the median line. On each 'episternum,' with the exception of that of the first pair, is a small oblique slit, the external opening of the pulmonary sacs. In addition to the absence of pulmonary apertures, the first abdominal segment further differs from the rest in the small size of the sternum, and in the presence of a pair of pectiniform appendages. Each appendage presents indications of being composed of several segments, and carries on its hinder border a row of close-set filaments.

The six segments which succeed the abdomen are the post-abdominal segments. With the exception of the first, which resembles the abdominal segments in its general shape, each segment is more or less cylindriform, completely chitinized, convex above and concave below, and marked with longitudinal serrated ridges. Attached to the last post-abdominal segment is a conical, somewhat tumid segment, which carries a strong curved spine upon its distal extremity, and may represent the 'telson' of the Crustacea. On the ventral surface, and in the interspace of the last two segments, is the anus.

46. A Scorpion (*Scorpio* ....), dissected to shew its digestive tract.

The alimentary canal is seen to be a straight tube, destitute of convolutions, and passing directly from mouth to anus. The liver is very large, occupying four-fifths of the thoracic cavity, and from it numerous ducts pass to the stomach. The anus is situated on the under surface of the last segment but one. The nervous system is seen at intervals underlying the digestive tract in the abdomen.

47. A gravid female Scorpion, dissected to shew the position of the embryos in an ovi-viparous Arachnid.

The dorsal surface of the animal has been removed. The embryos, differing from the parent only in size, are seen occupying the ovarian tubes, which overlie the liver or are even embedded in its substance.

48. A Spider, dissected to shew its nervous system.

The whole of the post-oral ganglia are seen to be concentrated into a single stellate mass, occupying the larger portion of the ventral surface of the cephalo-thorax. From this mass, which may be taken to represent the confluent thoracic and abdominal ganglia of Insecta, radiate, on each side, five principal nerves to supply the legs and maxillary palpi. Several nerves pass posteriorly from its hinder edge to supply the abdomen. The cephalic ganglia (two in number) are situated on the anterior edge of this stellate mass, between which and the former the œsophagus passes. From this pair of ganglia nerves are seen passing forwards to supply the eyes and mandibles.

Division ARTHROPODA BRANCHIATA.

Class CRUSTACEA.

1. Order *Decapoda.*

49. A Lobster (*Homarus vulgaris*), disarticulated, so as to shew its segmentation.

The different segments with their appendages have been as far as posible separated from each other, and serially arranged in their natural order. The segments have been numbered from the first, or ophthalmic segment, backwards. The carapace has been removed, and fixed on the right of the sub-abdominal segments.

The skeleton consists of a broad, shield-like carapace, 'cephalo-thorax,' and of the six segments, or 'somites,' which enter into the composition of the post-abdomen. Attached to the ventral surface of these different segments are the variously modified appendages, to the number of twenty pairs. These are named in order from the first segment as follows. In front of the mouth are a pair of eyes, a pair of antennules, and a pair of antennæ. Behind the mouth are a pair of mandibles, two pairs of maxillæ, three pairs of maxillipeds, five pairs of ambulatory legs, and six pairs of swimmerets: while to the last sub-abdominal segment is attached a median azygos element, the 'telson.'

A sub-abdominal 'somite,' which may be regarded as a typical one, is made up as follows. It is nearly semicircular in vertical section, the dorsal wall or 'tergum' being very convex, and the ventral wall or 'sternum' nearly straight or but slightly convex. At the infero-lateral angle both the 'tergum' and the 'sternum' are produced downwards and outwards into a lobate hollow process, termed the 'pleuron.' In the angle between the 'sternum' and the inner surface of the 'pleuron,' on each side, is an articular cavity, which receives the proximal extremity of the appendage attached to this 'somite.' A transverse groove marks off a crescentic area on the anterior surface of the 'tergum,' which is overlapped by the hinder part of the 'somite' in front of it. This area is the tergal facet. A similar flattened surface exists on the anterior portion of each 'pleuron.' This is the pleural facet. Each appendage consists of a basal attached portion (divided longitudinally into two segments), the 'protopodite.' Each 'protopodite' (sometimes called 'basipodite') carries at its distal extremity an external and internal filament, to the former of which the term 'endopodite,' and to the latter 'exopodite,' has been applied.

This description will in the main apply to the four central sub-abdominal segments, but the first and the sixth of these segments have their appendages somewhat modified for special purposes. In the sixth sub-abdominal segment, the 'exopodite' and 'endopodite' are enormously expanded into flat setose plates, and the exopodite is further divided by a transverse joint.

The 'telson' is a flattened conical setose plate, attached to the hinder margin of this 'somite,' and forms, with the expanded 'exopodite' and 'endopodite,' a powerful swimming tail.

In the first sub-abdominal 'somite' each appendage consists of two elements, the distal one of which is grooved on its inner face, and is capable, by being applied to its fellow, of forming a short cylindrical tube which probably conveys the male semen to the vulva of the female.

The 'cephalo-thorax' is formed by the fusion of the terga of the cephalic, the thoracic, and the abdominal segments. The cephalo-thoracic pleura are well developed, and extend so far downwards as to hide the bases of the appendages.

The sternal portions of the pleura are membranous and are reflected upwards to the roof of the cephalo-thorax, and then, after being deflected, become continuous with the partially calcified 'epimera.' In this specimen this membranous portion has been torn through by the separation of the tergal half of the cephalo-thorax from the coalescent sterna, which form the ventral surface of this part of the animal.

On the dorsal surface the 'cephalo-thorax' does not present any indications of division into distinct terga, corresponding to the sterna and appendages of the ventral surface, but nevertheless contains areas more or less distinctly marked out. A groove commences at the base of the antennæ, and, after passing directly backwards for a short distance, curves upwards and fuses with the corresponding curve of the opposite side at about the middle of the dorsum. The part in front of this suture has been called the 'cephalo-stegite,' and the portion behind the 'homo-stegite.' The 'homo-stegite' is further divided by two lateral linear depressions, one on each side of the median line, called the 'brancho-cardiac sutures,' and by a very faint transverse ridge, which is to be seen a little way behind the cervical suture, into a quadrangular area which corresponds externally with the position of the heart internally. In this specimen this area is tolerably well indicated by a boundary line of irregularly shaped white spots. The cervical suture indicates the line of separation between the cephalic and thoracic segments. The area between the cervical suture in front, and the faintly marked ridge behind, represents the confluent terga of the three thoracic segments, while that part of the 'homo-stegite' posterior to this corresponds with the terga of the five abdominal segments. The lateral areas which lie on the side of these median divisions represent the conjoined pleura of the eight thoracic and abdominal 'somites:' and from the fact that these areas cover in and protect the branchial chamber, they have been called 'branchio-stegites.' Anteriorly the 'cephalo-stegite' is produced into a long serrated rostrum. The sterna corresponding to the 'cephalo-thorax' are, like the terga, confluent, owing to the calcification of the membrane connecting the sterna and epimera of adjacent somites. The sterna which are in relation to the three posterior pairs of ambulatory legs are tolerably wide, but the sterna anterior to these become so narrow as to allow the bases of the appendages to meet in the median line. The calcified inter-epimeral, and inter-sternal membranes send inwards calcified processes, which, after dividing, reunite with each other in such a manner as to divide the floor of the cephalo-thorax into a series of inter-communicating chambers. A median canal is also formed by these processes, called the 'sternal canal.' It contains the thoracic portion of the ventral nervous cord, and is indicated by the insertion into it of a red glass rod.

The abdominal segments which have been already described are tolerably simple, and only slightly modified: but those appended to the 'cephalo-thorax' exhibit much greater diversity of form, and subserve a variety of functions.

Taking the segments in order, from behind forwards, and beginning with the first sub-abdominal or fifteenth body-segment, which has been already described, we find the following cephalo-thoracic appendages.

XIVth pair. (Ambulatory legs.)

Each appendage consists of a right 'protopodite' and a long segmented 'endopodite,' the 'exopodite' being absent. The joints of the appendage are named by Milne-Edwards as follows: 'coxopodite' ['protopodite'], which is attached to the 'somite,' and pierced by the external aperture of the 'vas deferens,' into which a black arrow has been inserted:—'basipodite,' 'ischiopodite,' 'meropodite,' 'carpopodite,' 'propodite,' and 'dactylopodite.'

XIIIth, XIIth, XIth, Xth pairs, (ambulatory legs,)

are similar to the fourteenth pair, but each possesses a long curved membranous appendage, which ascends from the 'coxopodite,' and in the natural condition penetrated into the branchial chamber. This is the 'epipodite.' Attached to each 'coxopodite' may also be seen a lamellar gill.

In the twelfth, eleventh, and tenth segments the 'propodite' is prolonged outwards into a process which bites against the 'dactylopodites,' and so forms the chelæ, which in the tenth pair are of great size.

IXth, VIIIth, VIIth pairs. (Maxillipeds.)

Each maxilliped is composed of three divisions, articulated to a 'coxopodite.' In the first maxilliped [No. IX.], the outermost of these three divisions, the 'epipodite' is a curved lanceolate lamina. A little in front of it is a gill, likewise attached to the 'coxopodite.' The middle division is a many-jointed palpiform filament, which corresponds to the 'exopodite.' The innermost element is the seven-jointed 'endopodite.' The second pair of maxillipeds [No. VIII.] much resembles the first, but the 'endopodite' is smaller and somewhat flattened, resembling the foliaceous 'endopodite' of the first pair. In the third pair [No. VII.] the 'endopodite' has been split into an inner flattened plate-like lamella and an outer flattened filament. The 'exopodite' is small, but the 'epipodite' is large, and in the specimen directed backwards.

VIth, Vth pairs. (Maxillæ.)

In the first pair [No. VI.] the 'endopodite' has been split into five divisions, and is in consequence somewhat foliaceous. The 'exopodite' is a flattened filament. The 'epipodite' is curved inwards. The 'endopodite' of the second pair [No. V.] differs from that of the first in having only three divisions. The 'exopodite' and 'epipodite' are absent.

IV^th^ pair. (*Mandibles.*)

Each mandible carries a jointed palp, which corresponds to the terminal joints of the mandibular 'endopodite' (Huxley). The calcified rod projecting outwards is the tendon of the adductor muscle of the mandibles.

III^d^ pair. (*Antennæ.*)

The antennæ are composed of a short basal 'protopodite,' which carries a long multi-articulated 'endopodite' and a short flattened scale-like 'exopodite.' The black arrow is inserted into the orifice of the duct of the 'green gland.'

II^d^ pair. (*Antennules.*)

A three-jointed 'protopodite' is succeeded by two long multi-articulated filaments, the 'exopodite' and 'endopodite.' An aperture protected by membrane in the proximal joint, and towards which the arrow points, is the auditory organ.

I^st^ pair. (*Ophthalmic peduncles.*)

The eye-peduncles are composed of two segments, the distal one of which carries the eye itself.

On the left of the specimen is a portion of the skeleton of a female, with the ventral surface turned upwards, so as to shew the openings of the oviducts on the 'protopodite' of the third pair of ambulatory legs. The two orifices are indicated by two black arrows. The first pair of post-abdominal appendages differs from those of the male in being simple unmodified filaments.

The structure of the stomach is illustrated by the two specimens marked *A* and *B*. In *B* the greater portion of the cephalothorax has been removed so as to expose the cavity of the thorax, with the stomach in its natural position. This viscus occupies nearly the whole of that part of the cavity which lies in front of the cephalic suture, and its membranous walls are supported and strengthened by a somewhat complicated arrangement of calcified bars and plates. It is divided transversely by a rather deep fissure into an anterior layer or cardiac portion, and a posterior smaller or pyloric division. The structure of the calcified gastric skeleton is as follows.

Crossing the stomach transversely, at the hinder border of the cardiac division, is a broad and slightly arcuated plate, the 'cardiac ossicle.' Attached to each extremity of this 'cardiac ossicle' is a curved triangular 'ptero-cardiac ossicle.' On each side a large elongated 'supero-lateral ossicle,' wider posteriorly than anteriorly, is connected with the lower end of the 'ptero-cardiac ossicle,' and passing upwards and backwards articulates by the anterior part of its hinder extremity with a small transverse rod, which forms the medial part of the anterior boundary of the pyloric portions, and is termed the 'pyloric ossicle.' The posterior part of the superior extremity of the 'supero-lateral ossicle' is connected with a triangularly shaped imperfectly calcified plate, the 'meso-pyloric ossicle.' Anteriorly this ossicle becomes continuous with the hinder edge of the pyloric ossicle. "These pieces, it will be observed, form a sort of hexagonal frame whose anterior and lateral angles are formed by moveable joints, while the posterior angles are united by an elastic meso-pyloric plate." From the middle of the cardiac piece a strong calcified process passes downwards and backwards underneath the 'meso-pyloric ossicle,' terminating in a broad thickened extremity, which may be termed the post-cardiac process, and to which is attached internally a broad and flat chitinous plate. This plate has its postero-lateral and internal angles slightly nodular. These nodules represent the cardiac teeth of the Common Cray-fish. A very narrow and uncalcified band connects the end of the post-cardiac process with a broad calcified process, the 'uro-cardiac ossicle.' This ossicle carries on its inferior surface a strong conical tooth, which projects into the cavity of the pyloric divisions of the stomach. Finally, connected in a similar manner with the end of the uro-cardiac piece, is a broad somewhat triangularly shaped ossicle, convex above and concave beneath, the 'pre-pyloric ossicle.' This passes upwards and forwards, and connects the uro-cardiac with the pyloric ossicle. In *A* the greater part of the meso-pyloric ossicle has been removed, so as better to exhibit the 'pre-pyloric ossicle' which lies beneath it. The post-cardiac process and the uro-cardiac ossicle, with its teeth, are also best seen in this specimen. The supero-lateral ossicle sends inwards from its inferior border a strong calcified process, which carries on its internal face the large lateral gastric tooth. On the infero-lateral parietes of the stomach there are several rod-like ossicles. To the inferior extremity of one of these, the 'lateral cardiac,' stretching downwards and backwards from the 'ptero-cardiac,' is attached a small ossicle, which internally bears a bifid tooth. The under surface of the stomach is strengthened by two nearly parallel rods, which extend from the pylorus forwards to the cardiac division, where they become divergent and more or less membranous. Their posterior extremities, also slightly divergent, are somewhat thickened, and each articulates with two rods, one of which is connected with the ossicle just described as bearing the bifid tooth, while the other joins the 'supero-lateral ossicle.' There are thus five gastric teeth, one median, and two lateral on each side.

In *A*, on looking into the gastric cavity and towards the pylorus, we can see, situated beneath the median gastric tooth, a bilobed valvular process; and on either side, immediately beneath the great lateral teeth, is a similar cushion-like process. These processes are beset with hairs, and by their mutual apposition form an efficient sieve to prevent the undigested food from passing into the intestine.

For an account of the structure and functions of the stomach of *Astacus fluviatilis*, which differ but little from that of the specimen described above, see Huxley, "*Medical Times and Gazette*," 1857, Vol. xiv. p. 255: also Rolleston, p. 90.

50. The cephalo-thorax and the first fourteen segments of a Langouste (*Palinurus vulgaris.*)

The same numbers have been affixed to the same parts as in the preceding specimen: and the description is in the main equally applicable.

51. A Lobster (*Homarus vulgaris*), dissected to shew its nervous system, which is of the type termed 'homoganglate:' that is, it consists of a longitudinal series of ganglia

of various sizes, united by nerve-cords, termed 'commissural cords,' and occupies the ventral surface of the body.

The total number of ganglia is thirteen. Of these, the first is the præ-oral or cephalic ganglion, from which are derived the nerves supplied to the eyes, antennæ, and antennules. Black bristles have been placed under these nerves. The remaining and post-oral twelve are equally divided between the thoracic and abdominal segments. The first post-oral ganglion (formed by the fusion of six embryonic ganglia) is of large size, and supplies six pairs of appendages, viz. the mandibles, two pairs of maxillæ, and three pairs of 'maxillipeds.' The five succeeding ganglia, smaller in size, and comparatively close together, supply the five pairs of ambulatory legs. The abdominal ganglia, still smaller in size and separated by greater intervals, supply the powerful abdominal muscles, and the segmental appendages. The last of these ganglia is of larger size than the rest, and gives off a leash of nerves to supply not only its own segment and appendages, but the 'telson.' The longitudinal commissural cord is double in the segment anterior to the abdomen, but in the latter region it is reduced by fusion to a single thread. Between some of the abdominal ganglia may be seen the 'nervi transversi.' These are small nerves given off from the longitudinal cord, at a point about midway between the ganglia.

52. A Cray-Fish (*Astacus fluviatilis*), dissected to shew the male generative system.

The whole of the heart and the greater part of the liver have been removed. The testes are situated immediately behind the posterior end of the stomach, and consist of two lateral halves, which posteriorly fuse into a long thin mass, situated in the median line. On either side the 'vasa deferentia' quit the gland at the junction of its three apparent lobes, and after describing a mass of convolutions on either side of the hinder part of the thoracic cavity, terminate by a small prominent orifice on the basal joint of the last pair of thoracic legs. A slip of blue paper has been placed under the terminal segment of each 'vas deferens.'

Rolleston, p. 106, sq.

2. Order *Stomapoda.*

53. A Stomapod (*Squilla mantis*), dissected to shew the same parts.

The double 'commissural cord' connecting the præ-oral with the post-oral ganglion is remarkably well seen. The remaining thoracic ganglia supply the thoracic legs. The abdomen contains six ganglia, each of which gives off two or more nerves on each side to supply the muscles of its segment. The longitudinal commissural cord connecting the different ganglia is more or less distinctly double throughout.

Sub-Class CIRRIPEDIA.

54. A Barnacle (*Lepas anatifera*).

The body of the animal consists of 'capitulum' and 'peduncle.' The peduncle is soft and fleshy, and invested externally with a tough rugose skin, which by its distal, clavate extremity serves to attach the animal. The 'capitulum' is somewhat triangular, consisting of two lateral valves, strengthened externally by several calcified plates, and encloses the major part of the body of the organism. The calcified pieces composing the valves are four in number, two in each valve. The superior or distal plates are called 'terga,' and the lower or proximal plates, also the largest, are called 'scuta.' The two valves are connected with each other along one side, through the intermediation of a mesial curved piece, the 'carina.' Within those valves the body of the animal is to be seen:—its dorsal surface in relation with the inner surface of the 'carina.' The body consists of a 'prosoma' which includes the cephalic segments—of six thoracic segments—and a tubular extension from the hinder edge of the last thoracic segment, which functionally is a penis, but morphologically may be the aborted representative of the abdomen, or post-abdomen, of other crustacea. The mouth is bounded anteriorly by a tumid, transversely extended labrum. Behind this we find, first, a pair of mandibles, each armed with a setose palp, and two pairs of maxillæ. Six pairs of appendages are attached to the thorax, each consisting of a basal 'protopodite' terminating distally in a long multiarticulated 'exopodite' and 'endopodite.' That part of the body which lies in front of the mouth, together with the whole of the peduncle, is the result of an extraordinary development of the pre-oral 'somites'—and the only appendage to be found in relation with these segments is a pair of sucker-like antennæ, to be seen by careful examination of the attached surface of the peduncle.

55. A Barnacle (*Lepas fascicularis*), dissected to shew its digestive system.

One half of the calcareous carapace has been removed, together with the investing membrane and the left testicular mass. A black bristle has been inserted through the mouth and œsophagus into the stomach, and a white one into the anus. The mouth, encircled by its mandibles and maxillæ, leads by a short œsophagus into a large oval or sub-globular stomach. The intestine is a simple tube of considerable size at its commencement. It bends upon the stomach, and proceeds along the dorsal aspect of the animal, gradually diminishing in size, to the anus, which is situated at the base of the penis.

Upon the stomach is a mass of dark-coloured glandular cæca, probably hepatic in function,—(a portion has been removed with the wall of the stomach,)—which communicate by several large orifices with its cavity. The cuticular lining of the œsophagus is continued for some distance into the stomach, and terminates therein by a well-defined serrated edge.

56. The same, dissected, to shew its hermaphrodite generative system.

In the upper of the two specimens on the tablet the carapace and investing membrane have been removed, and the organs displayed *in situ*, on the left side.

The testis, of irregular shape, is composed of minute branching cæca, and not only overlies the pyloric end of the stomach, but also gives off prolongations which enter the pedicels, and the basal segments of the rami of the cirri.

In the lower specimen a great part of the testis has been removed, so as to shew the 'vas deferens,' or dilated portion of the efferent duct of the testis, ascending parallel to the terminal portion of the intestine. It gradually diminishes in size to the base of the penis, where it joins the corresponding duct of the opposite side to form the common canal, which, after traversing the penis, opens at its end. A black bristle has been placed under the two ducts.

The ovaria are disposed in the peduncle and in the body. In the peduncle they may be seen as a tangled mass of branching tubes, filled with granular matter and immature ova. From the peduncle two main ducts (not seen in this specimen), one on each side, enter the body at the anterior corner of the rostrum, whence they curve round towards the base of the first pair of cirri. There they form two glandular masses resting on the upper edge of the stomach, of an orange colour, and generally subdivided near the mouth. These masses were thought by Cuvier to be salivary glands, but are now known to be true ovaries. No proper oviduct has yet been discovered. In the uppermost of the two specimens, between the body of the animal and the peduncle may be seen one of the ovigerous lamellæ in which the ova exist previous to their expulsion.

Darwin, "Monograph on the Cirripedia," p. 55, sq.

SUB-KINGDOM MOLLUSCA.

Division I. MOLLUSCOIDEA.

Class TUNICATA.

In the following preparations of Ascidians a *blue* rod has been placed in the inhalent, a *red* rod in the exhalent, aperture.

Rolleston, p. 66.

57. A simple Ascidian (*Cynthia microcosmus.*)

One half of the test, which in this species is of a leathery consistency, has been removed, to shew the animal suspended within it. The mantle is attached to the test at the two apertures, and is very muscular. Fibres may be seen passing in a longitudinal, oblique and transverse direction across its surface. The two apertures are regarded by some as homologous with the inhalent and exhalent siphons of the Siphonate Lamellibranchiates; and by others, as the mouth and anus.

58. One-half of the test, mantle, and branchial sac has been removed, so as to expose the cavity of the latter. The branchial

sac is of considerable size, with its walls produced into a series of parallel longitudinal folds, radiating from the inhalent orifice to the mouth. A black bristle has been introduced into the aperture leading from the branchial sac to the stomach—an aperture which has been regarded by some as the mouth, while others maintain that the mouth is better represented by the inhalent aperture.

59. To shew the nervous system.

The single nerve-ganglion is situated in the substance of the mantle on one side of the inhalent aperture, between it and the exhalent aperture, and is indicated in the specimen by the insertion of a black bristle behind it. The ganglion is fusiform in shape, and from its anterior and posterior ends nerves are seen passing towards the inhalent and exhalent apertures respectively.

The genital ducts are seen emerging from the lower margin of the first intestinal coil, and following the course of the intestine open into the atrium in close contiguity to the anus.

60. An Ascidian, of a different species, dissected to shew its digestive tract.

The external test has been removed, and the mantle and wall of the branchial sac reflected.

A black bristle has been passed through the inhalent aperture, branchial sac, and mouth, into the stomach, and a red rod through the exhalent aperture and atrial chamber. The mouth is situated at the bottom of the branchial sac, and leads by a short œsophageal canal into an oblong stomach. Proceeding from the stomach the intestine describes two curves, the first of which has its convexity directed towards the nerve-ganglion (marked by a black bristle being placed under it), and its concavity towards the heart. Hence the primary flexure of the intestine is said to be hæmal. The second curve has its concavity towards the ganglion, and terminates in a rectum which has its anal orifice in the atrial chamber. The floor of the stomach is seen to be marked by a longitudinal ridge, which is prolonged into and along the intestine, so as partially to divide the tube into two canals, by which arrangement the absorptive surface is much increased. On the side of the branchial one opposite to the mouth is to be seen a portion of the 'endostyle.'

Family *Salpidæ.*

61. A *Salpa maxima,* the asexual form. A green rod has been passed through the body-cavity, so as to protrude from the anterior and posterior orifices. The test is double, being composed of an inner and an outer layer: of which the latter is semi-transparent, uniform in texture, and almost colourless: the former is more opaque, of a yellowish tint, and provided with numerous transverse muscular bands. The two are seen to be united at one point on the right side near the posterior orifice.

Extending across the body-cavity diagonally, from right to left, are the branchiæ. In the left-hand lower corner is the liver, close to which is a young chain of sexual salps.

62. In this specimen the chain of sexual salps is nearly mature, and will shortly separate from the animal.

63. A chain of sexual forms of the same species. In the centre are two specimens, chained together, of *Salpa pinnata.*

Bay of Naples, 1874. F. M. Balfour.

Class POLYZOA.

64. A Sea-Mat (*Flustra foliacea*).

The zooids in the living specimen are contained within the ovoidal corneous cells of which the ramose and lamellar 'cænæcium' or 'polyzoarium' is composed. These cells are arranged on both sides of the frond in parallel longitudinal rows; examined with a lens, from four to eight short and blunt spines are seen to surround the broad end of each cell. The stone to which these fronds are attached is encrusted with these cells.

Class BRACHIOPODA.

65. Two specimens of *Lingula anatina.*

They have been attached to a sheet of mica. The valves are of a horny texture, and of nearly equal size, differing in this respect from the majority of the class, which have equilateral but inequivalve shells. Furthermore, the valves are not lateral, as in the Lamellibranchiata, but dorsal and ventral in relation to the animal they contain. Between the margins of the umbones the long muscular peduncle by which the animal is attached is protruded. The dorsal valve and mantle of the right-hand specimen have been removed, but the ventral mantle-lobe, with its margin and fringe of setæ, is left intact, adhering to the inner surface of the ventral valve. Little of the body, which occupies but a small part of the shell, can be distinguished, with the exception of a white glandular central mass, the liver, and the various muscles by which the adduction and adjustment of the valves is effected. The lateral margins of the mouth are produced outwards into two muscular ciliated 'arms,' which occupy quite one-half of the shell, and are curved inwards towards each other. The bases of the arms are connected with each other by a vertical membranous partition.

Division II. Mollusca Proper.

Class Lamellibranchiata.

66. A Fresh-water Mussel (*Anodonta cygnea*), removed from its shell, so as to shew the general relation of the mantle and branchiæ. The two strings by which the animal is suspended are attached to the mantle, one to each of its lobes. Bristles are inserted into the mouth and anus.

The mantle consists of two lateral lobes, confluent with each other along the medio-dorsal line, but free throughout the whole of their ventral margins. With the exception of the free, thickened, glandular, and shell-secreting ventral margin, which is homologous with the 'collar' of Gasteropoda, each pallial lobe is comparatively thin, and in the fresh condition nearly transparent. In the vicinity of the anus the free edge of each mantle-lobe is beset with a fringe of minute papillæ. This papillose border corresponds with that part of the mantle which in the siphonate Lamellibranchiata is produced into the cylindrical exhalent and inhalent siphons. There are two pairs of branchiæ on each side of the central body-mass; each gill is a flattened bag composed of longitudinal and transverse fibres, and richly ciliated. By the fusion of the two inner gill-lamellæ through the hinder third of their extent, the mantle-cavity is divided into a superior or anal chamber, into which the anus opens, and an inferior or pallial chamber. The anal chamber, indicated in the preparation by a white bristle, corresponds to the exhalent siphon. Anterior to this union the two laminæ are free, but are united to the body-mass anteriorly to this. On each side of the mouth is a pair of lamellar labial palpi.

67. A vertical section of an Anodon. The section has been taken through the heart and intestine, the organ of Bojanus, the visceral mass, and the foot. A white bristle has been inserted into the ventricle, through which the intestine is seen to pass. Immediately beneath the heart a black bristle is inserted into the great dorsal sinus, and right and left of this, a white bristle has been placed in the secretory portion of the organ of Bojanus, which overlies the excretory portion. The preparation also shews the relation of the mantle and the two pairs of gills to the median visceral mass. The three inferior bristles indicate sections of the intestine which have been cut through in the specimen.

68. The same, prepared to shew its digestive system.

The right lobe of the mantle and the right gill have been removed, and part of the muscular foot and liver cut away to shew the convolutions of the alimentary canal, which has been filled with a light blue injection. A blue glass rod has been placed in the mouth.

69. The same, prepared to shew the two muscles which serve to draw the valves of the shell together (the anterior and posterior adductor muscles). The strings by which the proportion is suspended are attached to the posterior extremity of the shell. Rolleston, p. 54.

70. The same, to shew its nervous system.

The animal is suspended on mica with its mouth upwards. Part of the muscular foot has been removed on the left side to shew the pedal ganglion *in situ*. Part also of the organ of Bojanus has been cut away to shew the nervous commissure connecting the cephalic with the parieto-splanchnic ganglion, and posteriorly the two inner lamellæ of the two inner gills have been separated so as to shew the commissure last mentioned throughout its entire length. The 'labial' ganglion is seen lying on the anterior retractor muscle of the foot, and immediately below the anterior adductor. Three commissural cords, under each of which a slip of blue paper has been placed pass off from it. The one which is seen passing vertically downwards along the base of the inner gill and through the organ of Bojanus, connects the labial with the parieto-splanchnic or branchial ganglion, which is seen lying on the posterior adductor. A little way to the left may be seen the terminal portion of the corresponding commissural cord of the opposite side. A slip of blue paper has been placed beneath it. A second cord is seen passing obliquely to the left, into the substance of the foot, to join the pedal ganglion. The third cord passes upwards towards the anterior adductor, and connects the labial ganglion with its fellow of the opposite side. From the pedal ganglion several nerves may be seen radiating to supply the muscular foot. A black bristle has been placed beneath a bundle of them. The two parieto-splanchnic ganglia of the two sides of the body are closely apposed, so as to form a transversely oblong mass. Nerves from these ganglia may be noticed passing to the mantle and inner gills.

71. Two Oysters (*Ostrea edulis*).

The upper specimen shews the single adductor muscle; the lower, the hinge-ligament, which causes the valves to open. Each valve is composed of a series of concentric calcareous laminæ, overlapping each other by their free margins.

72. A specimen of *Pholas dactylus,* to illustrate the arrangement of the mantle in a *Siphonate* Gasteropod.

A *red* rod has been placed in the exhalent orifice, and a *blue* rod in the inhalent.

The valves of the shell have been partially opened, so as to shew the union of the ventral margins of the mantle. In front the mantle-lobes are widely separated, so as to allow of the protrusion of the muscular foot between them. In front of the foot they are again united. Inferiorly the mantle-lobes are prolonged downwards into a cylindrical tube, divided into two canals by a median attachment. These canals are the exhalent and inhalent orifices.

Class GASTEROPODA.

Order 1. *Opistho-branchiata.*

73. A Sea-Hare (*Aplysia*), dissected to shew the general disposition of its organs.

In the upper of the two specimens on the tablet the rudimentary shell has been displaced to the right side of the animal, and the left mantle-lobe deflected, thus exposing the heart, branchiæ, and terminal segment of intestine.

The arborescent branchiæ, protected by the rudimentary shell, are situated behind the heart and towards the rear of the body (hence the position of the animal in the order Opistho-branchiata), but in front of the anus, into which a black bristle has been inserted. A black bristle has also been placed under the bilocular heart and the rectum.

In the lower preparation, the muscular envelope of the animal has been separated from the foot along the left side, and reflected to the right, together with the heart, branchiæ, and parts of the generative system. The digestive tract has been arranged mainly on the left side.

The ribbon-like salivary glands (two in number) have been pinned to the left of the animal's head. Posteriorly to the buccal mass the œsophagus is seen communicating with the stomach, which is divided by certain constrictions into three compartments, the last of which, from the muscularity of its walls, has been termed a gizzard. Surrounding the gizzard and communicating with it by a large duct is the liver. The intestine, on emerging from the liver, curves round the lower border of the specimen, and passes to the anus. On the exterior of the liver is the hermaphrodite gland, a white, irregularly shaped, granular mass. From it a slightly convoluted hermaphrodite duct passes forwards to the albuminiparous gland; and after this junction and the reception of the duct of a minute vesicle (seen near the anterior margin of the gland), the duct passes upwards as a much larger tube to its external opening, prior to reaching which it communicates with a globular spermatheca. A little to the right of this part are the heart and branchiæ. A bristle has been placed under the former.

The nervous collar, consisting of supra-œsophageal and sub-œsophageal ganglia, connected by commissural strands, is seen surrounding the œsophagus. From the sub-œsophageal ganglia two nervous chords pass obliquely to a ganglion on the right, (indicated by a black bristle), situated immediately in front of the spermatheca: from this ganglion nerves are given off to the genitals, liver, and branchiæ. From the cephalic ganglia nerves are seen passing to the tentacles.

Order 2. *Prosobranchiata.*

74. A Common Whelk (*Buccinum undatum*).

The proboscis has been extended to its full length, and a blue rod inserted in the mouth. The foot and operculum are in the positions which they would assume when the animal is in motion.

75. Another specimen, to shew the structure of the proboscis, which has been laid open. A blue rod has been inserted into the œsophagus. At the end of the proboscis is seen the strap-like tongue, armed with a treble row of horny teeth. At the end of the proboscis nearest to the head it is marked horizontally with numerous striations, indicating the mode in which it is folded upon itself within the body of the animal. Its termination, which is not so marked, remains unfolded when the organ is drawn in. The movements of the tongue are effected by the longitudinal muscles seen beneath the œsophagus.

76. Another specimen, to shew the penis and the sperm-duct.

The penis has been protruded, and a portion of the shell taken away so as to shew the sperm-duct, under which, where it emerges from the body of the animal, a black bristle has been placed. The penis is a very large, flattened organ, and when laid open is found to be composed of interlacing muscular fibres. The sperm-duct, having pursued a tortuous course through the penis, terminates by opening externally at the extremity of a projection near its blunt end.

77. Another specimen, to shew the digestive tract.

The whole of the mantle has been removed, the animal suspended by its penis and proboscis, and the alimentary canal partially filled with red injection. The proboscis has been unfolded and laid open so as to display the commencement of the alimentary canal, into which a blue rod has been inserted.

The œsophagus is of considerable length. At the base of the proboscis it is clasped by large, coarsely-lobed, irregular, salivary glands whose ducts open into it, as does a long and apparently glandular cæcum, which is coiled round its subsequent portion. Before it reaches the stomach there is a small conical crop. The stomach is somewhat peculiar in shape, of moderate size, and has its œsophageal end produced into a short conical cæcum. A black bristle has been placed under this portion. The intestine, compared with the preceding portion of the digestive tract, is remarkably short. Its primary flexure is hæmal, and its terminal segment, or 'rectum,' very large and capacious. The anus opens into the pallial cavity, and is indicated by the insertion into it of a red rod. Near the pyloric end of the stomach is the bi-locular heart.

78. A specimen of *Triton rugosus*, prepared to shew the relation of a Branchio-gasteropod to its shell, when it is retracted within its shell, and the mouth closed by the operculum.

The first whorl of the shell, being broken away, shews the broad muscular foot; the tentacles behind; and further still the proboscis, much retracted, which has been made visible by removing a portion of the overlying integument. Behind this again is seen the mantle, a large portion of which has been cut away, so as to expose its cavity, in which are contained the gills, the exhalent siphon, and the intestine. The branchiæ are seen as a fringe, depending from the lower border of the mantle-cavity. A blue rod has been placed in the anus, a red rod in the exhalent siphon. At the termination of the branchiæ the liver commences, and occupies the last two whorls of the shell.

Order 3. *Pulmonifera.*

79. The upper specimen on the tablet, a Garden Snail (*Helix aspersa*), shews the position and relations of the aperture of the pulmonary sac when the animal is in motion. The aperture,

into which a white bristle has been inserted, is situated immediately within the peristomial margin of the shell, a little to the right side of the animal, but to the left of the anus, which is indicated by a black bristle.

In the lower of the two specimens, a Roman Snail (*Helix pomatia*), nearly the whole of the shell has been removed, and a red injection thrown into the auricle and pulmonary vessels. An incision has been made transversely through the roof of the pulmonary sac, and its interior exposed by turning back the posterior flap. A black bristle has been passed through the external orifice into its cavity. Attached to the displaced posterior half of the sac is the pale-coloured and triangular kidney, and close to it on the left side the bilocular heart.

The floor of the respiratory cavity is non-vascular, being composed of muscular fibres arranged transversely and longitudinally: and functionally representing a diaphragm. On the right side of this floor the rectum may be seen passing forwards to the anus, which is situated to the right of, but in close proximity to, the respiratory orifice.

80. A Roman Snail (*Helix pomatia*), dissected to shew the general disposition of its organs.

The shell has been removed. The liver, heart, and pulmonary sac have been arranged on the left side of the preparation, the stomach and salivary glands in the middle, and the generative system mainly on the right side.

Posteriorly to the buccal mass, and on emerging from the nerve-collar through which it passes, the œsophagus expands into a long and fusiform stomach. The salivary glands overlie the stomach about the middle of its length, and the two ducts therefrom pass forwards through the nerve-collar and pierce the buccal mass anteriorly to it. Posteriorly the stomach diminishes in size, and at its point of junction with the intestine receives the single large hepatic duct. The first segment of the intestine ascends towards the heart, and, together with the stomach, makes up a curve having its concavity towards the pedal ganglia. Hence its primary flexure is said to be neural. Below the heart the intestine describes certain convolutions in the substance of the liver, and reappearing on the extreme left of the preparation, proceeds straight to the anus, which is indicated by a black bristle. The nerve-collar (through which a black bristle has been passed) encircles the œsophagus. From the supra-œsophageal portion delicate nerves pass forwards to supply the tentacles, lips, &c. A little to the left of the left salivary duct may be seen the left parietal nerve, double at its termination, passing from its origin in the parieto-splanchnic ganglion to its peripheral distribution in the body-walls. Between the left salivary duct and the stomach the central portions of three other nerves may be seen in connection with the same ganglia, viz. the two parietal nerves of the right side and the great visceral nerve in connection with the aorta. The second black bristle (the lower one) is inserted into the anterior aorta, which passes through a foramen between the upper or parieto-splanchnic, and the lower or pedal portion of the sub-œsophageal mass.

On the left of the preparation is the pulmonary sac. The greater portion of its diaphragm-like floor has been removed, and its highly vascular roof exposed. At the lower edge of the sac, and on the right side of it, is the bilocular heart. To the left of the heart is the pale triangular kidney.

The hermaphrodite gland is lodged in the concavity of the penultimate and ante-penultimate coils of the liver, which occupy the lowest part of the preparation. From this gland a convoluted hermaphrodite duct passes upwards to a tongue-shaped body, the albuminiparous gland; and after this junction the duct passes upwards again as a thicker and much plicated tube, having closely applied along it a ribbon-like glandular prostatic mass. At about the level of the animal's head this hermaphrodite duct divides into the oviduct and the vas deferens. The vas deferens passes forwards and joins the base of the penis at the point where the long whip-like flagellum also joins it. On the extreme right of the preparation is the globular spermatheca with its duct leading to the oviduct into which it opens. Connected with the vagina is the 'dart sac,' and between the latter and the oviduct are seen the 'multifid vesicles.'

The external generative opening is on the right side of the animal at the base of the right superior tentacle.

81. A Roman Snail (*Helix pomatia*), dissected to shew its nervous system.

The viscera have been removed, with the exception of the buccal mass, œsophagus, and portions of the generative system.

The œsophagus has been drawn through the nerve-collar and pinned in front of the animal's head.

As in other Gasteropoda the central nervous system forms a collar encircling the œsophagus. The supra-œsophageal part of the collar is composed of the two cephalic ganglia and the broad commissural band connecting them. The sub-œsophageal ganglia, which are connected with the former on each side by a double nervous cord, consist of a lower or pedal, and an upper or parieto-splanchnic element. From the former of these elements nerves may be seen passing to the muscular foot, while from the parieto-splanchnic portion three large nerves pass off to supply the parietes. Of these, two pass to the right side, and one, which bifurcates, to the left. Arising from the same source is the great splanchnic nerve. This nerve proceeds posteriorly, in close proximity with the anterior aorta, as far as the albuminiparous gland, at which point it divides into two branches, one of which goes to the liver, and the other to the hermaphrodite gland. The anterior aorta passes forwards through a foramen between the parieto-splanchnic and pedal ganglia to supply the anterior part of the body. This fact, together with the distribution of the nerves of the two ganglia respectively, enables these two elements of the sub-œsophageal mass to be differentiated.

From the cephalic ganglia nerves, under which a slip of blue paper has been placed, may be seen passing forwards to supply the superior or eye-bearing tentacles, together with the upper lip and adjacent sensitive surface.

From each cephalic ganglion a nerve passes to join a small stomato-gastric ganglion, situated on either side of the point at which the œsophagus joins the buccal mass. The two stomato-gastric ganglia are connected by a commissural strand, and from each nerves are given off to supply the buccal mass, salivary glands, and œsophagus.

82. A Grey Slug (*Limax cinereus*), dissected to shew the general distribution of its organs.

The muscular envelope of the animal has been separated from the foot proper along the left side, and turned over to the right, together with the shield-shaped mantle, heart, and pulmonary sac. The digestive tract and the glandular organs in connection with it have been displaced from their natural positions and pinned to the tablet on the left side of the preparation, while the generative organs, similarly displaced, occupy the right side. The superior tentacles have been pinned by their retractor muscles in front of the animal's head.

On the left side of the head are the salivary glands, two lobulated organs connected with the mouth by two ducts which pass forwards through the nerve-collar and pierce the buccal mass anteriorly to it. The glandular mass which encircles the anterior margin of the buccal mass is 'Semper's organ,' supposed by its discoverer to be olfactory.

The œsophagus, emerging from the buccal mass, passes through the nerve-collar, and almost immediately expands into a long fusiform stomach, the posterior segment of which, separated from the anterior three-fourths by a slight constriction, receives the two biliary ducts, one from each of the two principal lobes into which the liver is divided. A convoluted intestine succeeds the stomach, passing to the middle line of the body, where, after a short retrograde course posteriorly, it bends sharply upon itself, ascends, and terminates at an anus situated on the right side of the respiratory aperture.

In the upper portion of the specimen, and on the right side, is seen the reticulated structure of the roof of the pulmonary sac, the floor having been removed.

A little posterior to this point is seen the bilocular heart, together with portions of the two trunks into which the aorta is divided. Beneath the heart is the sub-triangular yellow kidney. In the natural position of these parts the kidney would of course overlie the heart. Immediately posterior to the buccal mass, and encircling the œsophagus, is the nerve-collar, consisting, superiorly, of the two cephalic ganglia connected with each other by a broad commissural band, and inferiorly of the parieto-splanchnic and pedal ganglia. The supra-œsophageal and sub-œsophageal masses are mutually connected by a double commissural strand embracing the gullet.

From the cephalic ganglia nerves may be seen passing anteriorly to supply the tentacles, 'Semper's organ,' and the adjacent parts. From the upper or parieto-splanchnic segment of the sub-œsophageal mass nerves are given off to the parietes and viscera. Of the visceral nerves, the peripheral divisions have been removed, their origins alone remaining. From the lower or pedal segment a leash of nerves passes off to supply the muscular foot. A black bristle (the longest of the two) has been inserted into the foramen which gave passage to the anterior branch of the aorta.

In the angle which the gullet makes with the buccal mass, and situated on the latter, is the right stomato-gastric ganglion of the sympathetic system.

Of the generative organs, the hermaphrodite gland (situated at the bottom of the right side of the tablet) is connected by a single convoluted duct with the large, somewhat irregularly shaped, and coarsely lobulated albuminiparous gland.

The duct, on emerging from the gland, is of much larger size and plicated. It has associated with it throughout the greater portion of its length a ribbon-like granular prostatic mass. Immediately above the pulmonary sac this subdivides into a long thread-like duct, or 'vas deferens,' which joins the root of the penis, and a short, thick oviduct which opens outwards.

In the re-entering angle between the penis and the oviduct, and communicating with the latter, is the globular spermatheca. The penis, pinned by its retractor muscle a little to the right of the right superior tentacle, is seen to communicate by its saccular portion with an aperture common to it and the oviduct. The 'multifid vesicles,' and 'dart sac,' so characteristic of the majority of the European Helicidæ, are absent.

83. A Black Slug (*Arion empiricorum*), dissected to shew its general anatomy.

The structure of this species differs in no very important respect from the last. The most noteworthy points of distinction are the following:—the extremely lobulated and diffuse character of the salivary glands and liver; the large and compact hermaphrodite gland, and the smaller and more finely lobulated albuminiparous gland. The spermatheca also is larger, and connected by a much shorter duct with the vagina.

On the right side of the preparation the heart is well displayed, and proceeding from it the aorta, divided into its anterior and posterior branches, the former of which passes anteriorly to supply the organs of that part of the body, while the latter passes posteriorly to supply the liver and intestine.

A yellow glass rod has been placed under the cephalic ganglia, and a red rod under the sub-œsophageal mass.

84. A wax model of a Grey Slug (*Limax cinereus*), prepared to shew its general anatomy.

A. The animal entire.

B. Anterior half of the animal. A portion of the mantle has been removed in order to expose the rudimentary shell which would not otherwise be seen.

C. General disposition of the internal organs, in their natural position, on the removal of the integument.

D. The organs have been partially separated in order that the general disposition of the alimentary canal and the generative organs may be seen.

E. Designed to shew the salivary glands, the nervous system, and the pulmonary sac; together with the heart and kidney.

F. The generative system.

G. The buccal mass laid open to shew the odontophore and the nervous system.

The numbers affixed denote the different organs as follows:

1. Buccal mass.
2. Salivary Glands.
3. Stomach.
4. Intestine.
5. Liver.
7. Rectum.
8. Anus.
9. Renal organ.
10. Duct of Renal organ.
11. Ventricle.
12. Auricle.
13. Anterior Aorta.
14. Posterior Aorta.
15. Pulmonary vessels lining roof of pulmonary sac.
16. Branches of posterior aorta supplying viscera.
17. Supra-œsophageal ganglion.
18. Sub-œsophageal ganglion.
19. Right and left stomatogastric ganglia.
20. Buccal mass laid open to show odontophore.
21. Duct of salivary gland.

22. Hermaphrodite gland.
23. Shell.
24. Shield-shaped mantle.
25. Albuminiparous gland.
26. Penis.
27. Hermaphrodite duct.
28. Vas deferens.
29. Oviduct.
30. Spermatheca.

Class CEPHALOPODA.

85. A Cephalopod (*Eledone*).

A *blue* rod has been inserted into the mouth, a *red* rod into the funnel.

The body is symmetrical, the organs being arranged symmetrically with reference to an imaginary vertical plane drawn from before backwards through the centre of the body. The animal is divided into an anterior or cephalic portion, ‘prosoma,’ and a posterior, or ‘metasoma.’ In the centre of the ‘prosoma’ and surrounded radially by the arms, is the mouth, and on the opposite sides of it are the sessile eyes. The eight muscular arms which surround the mouth correspond to the anterior portion of the foot, ‘propodium,’ of the Gasteropoda, and are formed by the extension of the antero-lateral parts of the foot forwards in front of the head, and their union with each other in front of the mouth: so that this aperture, from its position in front of the anterior margin of the foot, comes to lie in the centre of it. The margins are produced into long muscular processes or arms; which, in this species, are set with a single row of suckers, by means of which the animal can attach itself to foreign bodies, seize its prey, or move from place to place.

The ‘metasoma,’ which contains the chief organs of vegetative life, is invested externally with a thick muscular coat, or mantle. This terminates in front freely, and so allows the entrance of water into the pallial cavity. On the dorsal surface of the specimen a muscular tube may be seen emerging from the pallial cavity: this is the ‘Funnel.’ It is formed by an extension of the ‘epipodia’ upwards, and their subsequent fusion in the medio-dorsal line. The Funnel is broader posteriorly than it is anteriorly, and its base is covered by the superior margins of the mantle.

The *Octopoda*, to which this species belongs, have no internal skeleton of any kind. The specimen was taken at Algiers.

86. A Calamary (*Loligo vulgaris*), dissected to shew its internal skeleton, the 'gladius' or 'pen.' The 'gladius' extends throughout the whole length of the dorsal portions of the mantle. It is of a horny texture, dark in colour, and consists of a median shaft with two lateral alæ. It lies loosely in the cavity, so as easily to fall out when the integument is cut away. This species represents the family *Teuthidæ*.

87. A Sepia (*Sepia officinalis*), dissected to shew the position of the internal skeleton, or 'cuttle-bone.' The 'cuttle-bone' is imbedded in the dorsal integument. It is a light, cellular, calcareous body, peculiarly characteristic of the genus Sepia. Its form is an elongated oval, convex, and marked by a slight median keel on the dorsal surface; and partly convex and partly concave on the ventral surface. The margin of the 'bone' is seen to be more or less horny, and darker in colour. This species represents the family *Sepiadæ*.

88. Portion of 'cuttle-bone' from a Sepia, treated with acid to remove the earthy matter, and shew the laminated structure of the residual animal matter.

89. The lips and jaws of a Sepia (*Sepia officinalis*).

A portion of the lips has been removed, and a black and white bristle passed through the mouth into the œsophagus.

The lip, which surrounds the mouth loosely, is beset with numerous elongated papillæ. The jaws consist of two horny beaks of a brown colour, in shape not unlike those of a parrot. They are embedded in a mass of muscular fibres by which the movements of the jaws are regulated. The margin of the lower one overlaps that of the upper. Between them is seen the tongue with its serrated surface. From the hinder portion of the buccal mass the œsophagus may be seen passing downwards through the cartilaginous ring towards the stomach.

90. A Cuttlefish (*Eledone*), dissected to shew its digestive, respiratory, circulatory, and generative organs.

The bag containing the viscera has been laid open, and the mantle pinned back. An incision has been carried through the cartilaginous ring at the base of the tentacles and the muscular mass surrounding the jaws, so as to expose the origin of the œsophagus. This is a narrow tube, which, after a course of uniform diameter for about an inch, suddenly expands into a large, easily dilateable, 'crop' (pinned to the right in the preparation). A short passage leads thence to the stomach, a small muscular organ which has been called 'gizzard,' from its muscularity. Close to, and opening into, the stomach is the spiral cæcum; a little beyond this the intestine receives the duct of the liver, and then proceeds in an upward direction to the anus, which is situated near the 'funnel.' The liver is a large globular organ, containing within its substance the inkbag, the duct of which opens into the intestine near the anus. There are two sets of salivary glands. The uppermost are closely attached to the under surface of the buccal mass, and open by a single duct into the œsophagus. The lower pair are larger and have each a duct, which shortly unite to form a common canal, opening into the buccal mass at the base of the tongue.

On either side of the lower part of the preparation are the branchiæ, each with its venous heart attached. The great venous trunk has been removed, but the cut end of one of the two veins that unite to form it has been stitched back in the centre of the preparation. A piece of red glass indicates the aorta. On the left of this is the great pallial ganglion, from which numerous nerves may be seen radiating into the substance of the mantle. Between the two venous hearts, arching over the systemic heart, are the two venæ cavæ, furnished with clusters of 'spongy cellular bodies.' At the bottom of the preparation is the ovary, with its ducts, of which one is pinned out to the right.

91. Circulatory system of the same species. The arterial portion has been injected with blue. The systemic heart is in the centre; on either side of it are the venous dilatations into which the blood is received from the branchiæ, prior to its reception by the ventricle. Pinned on the right and left sides of the preparation, and uninjected, are the pulmonary hearts, with their so-called 'appendages.' From the systemic ventricle the anterior and posterior aortæ may be seen passing respectively upwards and downwards.

From a specimen taken at Weymouth.

SUB-KINGDOM. VERTEBRATA.

Division I. ANALLANTOIDEA.

Sub-division I. ICHTHYOPSIDA.

Class PISCES.

Order TELEOSTEI.

92. A common Perch (*Perca fluviatilis*).

The roof of the cranial cavity and the greater part of the left wall of the abdomen have been removed, exposing the brain and most of the internal viscera. The following external features may be noticed: the absence of distinct divisions between cephalic, thoracic and caudal regions; the imbricated scales of the variety called ctenoid; the paired, and median unpaired fins supported by hard, unbranched, non-striated rays, and by soft, branching, striated rays; the large size of the eyes; the absence of distinct eyelids; the presence of persistent visceral clefts interposed between the visceral arches, and protected partly by a long operculum and partly by a membrane supported on a series of branchio-stegal rays. Bristles are inserted into the paired cæcal nasal sacs, each of which has two apertures. The pectoral fins are situated a little behind the free edge of the operculum; and behind these again are the paired ventral fins. All the rays of the pectoral fins are soft, but the first ray of the ventral fin is hard. The mesial fins are the dorsal, divided into two divisions, the anterior of which is composed entirely of hard rays, as is the rule in Acanthopterygian fishes, the caudal, and the anal. "A series of scales perforated by mucous ducts supplied with nerves forms a lateral line along the trunk, the contour of which corresponds with that of the upper line of the back." (Rolleston.) A portion of the skin has been removed from the lateral surface in the vicinity of the head—thus exposing the lateral branch of the pneumogastric nerve, which passes posteriorly in relation with the lateral line. A slip of blue paper has been placed beneath this nerve. The tendinous intersections dividing the great lateral muscles into a series of segments, may also be noticed.

A blue injection has been thrown into the gills, which are four in number on each side. Each gill carries on its outer or convex edge a double row of short, flattened, vascular filaments, and on its inner or concave side a row of short bony tubercles. In the angle between the converging gills are to be seen the central parts of the circulatory system, consisting of a triangular ventricle, leading into the pulmonary aorta anteriorly, an auricle which slightly overlaps the ventricle, and a 'sinus venosus,' into which the great veins pour their blood. The heart is separated from the subjacent liver by a transverse peritoneal partition. The latter viscus is of large size, rounded in front and above, or divided inferiorly by a deep fissure into a right and left lobe. Depending as it were from beneath the inferior edge of the liver is the cæcal stomach, with the intestine, to which are appended three pyloric cæca passing out of it at right angles. After describing an S-shaped convolution, the intestine expands into a dilated, thin-walled, and transparent rectum. Behind the rectum is the single large, pear-shaped ovary, and still more posteriorly the small oval bladder. The spleen lies in a loop of intestine, and a portion of it, stained with the blue injection, is to be seen between the lower edge of the stomach and the ovary. The large semi-transparent air-sac, closely applied to the hinder wall of the abdomen, has been left intact in the greater part of its extent; but the posterior third has been removed, in order to expose a portion of the kidney, which lies between it and the vertebral column throughout the whole extent of the abdomen. A slip of blue paper has been placed beneath one of the ureters. The anus is situated anteriorly to the openings of the generative and urinary ducts, and not posteriorly, as in the higher Vertebrata.

In the brain the cerebral hemispheres are small, and their surfaces are slightly corrugated. From their anterior extremities the olfactory nerves are given off. The optic lobes, which succeed them, are the largest divisions of the brain : and by their opposition to the hemispheres in front, the optic thalami are hidden from view. The next division is the small, smooth cerebellum, and the fourth ventricle which it bounds anteriorly is widely open. (Rolleston, p. 40.)

Class II. AMPHIBIA.

Order BATRACHIA.

93. A Common Frog (*Rana temporaria*), dissected and injected to shew the reni-portal system, and the chief trunks of the arterial and venous systems.

A white bristle has been placed beneath the crural vein; if this vein be traced upwards from the leg it will be seen that in the groin it divides into two branches, and that one of them, the outer one, passes upwards to the kidney, along the outer side of which it runs, and ultimately breaks up into capillaries in that organ. This is the reni-portal vein. The second branch of the crural curves round the front of the groin, towards the medio-ventral line, where it unites with the corresponding branch of the crural vein of the other leg to form the epigastric or umbilical vein. The latter vein, after receiving one or two small twigs from the large and persistent allantois, passes up the median line of the abdomen till it reaches the liver, where it joins the portal vein, and subsequently ramifies through that organ. It will thus be observed that the whole of the blood in the hinder extremities of the body, after passing through the capillaries proper to these parts, traverses in addition one of two sets of capillaries, either going by the reni-portal vein to those of the kidney, or by the epigastric to those of the liver. The hepatico-portal system is also shewn. A loop of intestine has been pulled out and fastened to the right side of the animal. The veins of the intestine are seen to unite and re-unite, and by successive unions to form the portal vein which passes upwards to the liver. The left superior vena cava is, as usual, formed by the union of the jugular and subclavian veins. A black bristle has been placed beneath it, just before it curves round the base of the heart to reach the right auricle. The large inferior vena cava is formed by the confluence of the veins from the two kidneys, between which it is to be seen. It passes forwards in relation with the posterior surface of the liver, and, after receiving the hepatic veins, enters the right auricle. (The liver has been displaced to the right so that the posterior surface has, in this specimen, become the anterior.)

Arterial System.—On the left side of the heart the three trunks into which the 'bulbus arteriosus' divides on that side are also to be seen. A slip of blue paper has been placed beneath them: the most anterior of the three is the carotid. The central one, which is the systemic aorta, after giving off the subclavian and vertebral arteries (the roots only of these are seen), passes downwards and joins its fellow of the opposite side, to form the abdominal aorta. The mesenteric artery which supplies the intestines is given off immediately below this junction. The third trunk is the pulmo-cutaneous artery—the pulmonary branches, proceeding to the lungs, only being seen, as the cutaneous branch has been removed. After giving off the mesenteric artery, the abdominal aorta disappears behind the kidney, though at some distance inferiorly one of its branches, the crural artery, passes downwards over a black bristle, to supply the right leg.

94. A Frog, dissected to shew its nervous system.

The nervous system consists of a brain and spinal cord. The cerebral hemispheres are much elongated, and are, as in all Vertebrata except fishes, the largest division of the encephalon. Olfactory nerves are given off from their anterior extremities to the nasal sacs. The optic thalami which succeed are largely exposed between the hemispheres and the corpora bigemina. The latter are comparatively small. The fourth ventricle is widely exposed, and the only representative of a cerebellum is the narrow band of transverse fibres which is to be seen crossing over the anterior part of the ventricle. The spinal cord is short and stout, and nerves are given off from it to the number of ten pairs. The pia mater of the cord is continued as a thin sheath, destitute of nervous matter, to the extremity of the neural canal. The last two or three pairs of spinal nerves pass backwards in the spinal canal for some little distance before passing out to their peripheral distribution. The ganglia on the posterior roots at the point where they join the anterior roots are to be seen. A slip of blue paper has been placed under the two ganglia. On the ventral surface of the throat slips of blue paper have been placed beneath two cranial nerves and the first spinal, viz. the glossopharyngeal, pneumogastric and hypoglossal.

95. A Frog, dissected to shew certain features not shewn,

or but imperfectly shewn, in the previous preparations. The greater part of the stomach and intestine has been removed, a portion of the dilated rectum alone remaining. The heart, consisting of two auricles and a ventricle, is seen in the mesial line at the base of the throat. The carotid with its bulb-like carotid gland and the lingual artery which it gives off, the systemic and pulmonary trunks, into which the aortic bulb divides on each side, are perhaps better seen. The same remark will also apply to the left musculo-cutaneous vein, which is to be seen returning the blood from the vascular and respiratory skin to the left superior vena cava. On each side of the heart are the simple sac-like but internally vesicular lungs. Below the heart are two lobes of the liver, the third having been removed to shew the large gall-bladder and the root of the epigastric vein. A little to the right of the darkly stained gall-bladder is the globular spleen. The two oval white bodies seen beneath the liver are the testes. The vasa deferentia emerge from and pass through the substance of the anterior part of the kidney, and finally open into the uro-genital duct, which can be traced down the outer edge of the latter organ. To the terminal part of each of these ducts is appended a large lateral dilatation, the vesicula seminalis. The large bifid allantois hangs down in front of the rectum.

Division II. ALLANTOIDEA.

Sub-division. SAUROPSIDA.

Class AVES.

Order CARINATÆ.

96. A Pigeon (*Columba livia*), dissected to shew the chief features by which it differs from a Mammal.

The roof of the cranial cavity has been removed and the brain exposed. The right wall of the chest and abdomen has also been removed. The origins of the well-developed pectoralis major and pectoralis minor muscles are to be seen along the edge of the sternal keel. The skin has been removed from the front of the throat, and the crop, after having been distended with spirit and hardened, has been laid open and its cavity displayed. The cerebral hemispheres are pear-shaped, with a smooth surface, and differ from the corresponding parts of the Reptilian brain in being in contact with the cerebellum, and also by reason of their much greater size. The cerebellum is large, and divided by numerous transverse 'sulci' into well-marked lobules. It has no lateral lobes. The 'corpora bigemina,' instead of being in contact with each other mesially, as is always the case in other Vertebrates, are thrown down towards the infero-lateral surface of the brain, so that they appear as rounded lateral projections. The other points to be noted about the head, which is supported upon a long neck consisting of more than seven vertebræ, are the presence of feathers; the absence of a 'concha' to the external auditory meatus; a well-developed third eyelid, which can be drawn vertically across the eye; the edentulous character of the mouth; the horny and non-prehensile tongue; and the absence of an epiglottis. The widely dilated œsophagus expanding below into a bi-sacculated crop occupies the front of the flexible neck. The cartilaginous tracheal rings are complete. Between the chest and the abdomen the absence of a diaphragm is to be remarked. In the chest, and occupying a mesial position, is the long, acutely conical heart. The short, thick aorta which it gives off, is seen to divide into three large trunks, two 'arteriæ innominatæ,' and a descending aorta. The aorta curves over the right bronchus and not over the left, as in the Rat. Behind the crop, and lying in close apposition with each other, in a deep groove formed on the anterior surfaces of the cervical vertebræ by the inferior transverse processes, are the two carotids. A piece of blue paper has been placed beneath them. The right lung is also seen in section. It is not divided into lobules, nor is it suspended in a pleural cavity; but is so firmly connected by connective tissue to the back and side-walls of the chest as to be marked by deep grooves, the impressions of the ribs. Each innominate artery divides into three branches—the carotid, subclavian, and pectoral arteries. Below the heart is the liver, composed, as in most reptiles, of a large right lobe and a smaller left one, the two being connected by a transverse lobe. The apex of the heart is received into a mesial depression between the two lobes. Overlapped by the left lobe, and partially concealed by it, is the thick-walled and muscular gizzard: the intestine, with the exception of part of the duodenum and the rectum, has been removed. The duodenum hangs down from the gizzard, and contains within its primary convolution the compact pancreas, with the three ducts by which its secretion is poured into the intestine. In addition, two other ducts, one of considerable size, and the other very small, are seen leaving the liver and joining the duodenum. These are the hepatic ducts. The right testis is also to be seen, as a large ovoid whitish body. A little beneath and behind the testis is the tri-lobed kidney. Each of its lobes lies in a depression in the under surface of the ischium. The ureter emerges from its inner edge, and passes posteriorly to its cloacal outlet. A little to its outer side is the sinuous vas deferens. The rectum hangs down from the bottom of the specimen, and about an inch from the anus two small conical cæca join it. On the dorsal surface of the extreme tip of the tail is the uropygial gland, consisting of two pear-shaped lobes. The biceps muscle of the right leg should be noticed passing downwards from the ischium. It passes through a pulley-like loop of tendon at the back of the knee to its insertion in the tibia.

Class MAMMALIA.

Order RODENTIA.

97. A Rat (*Mus decumanus*), dissected to shew the distinctive features of its class.

In addition to the more important anatomical details, the following external points should be noticed: the hairy skin, the existence of distinct outlets for the urinary and generative organs as well as for the intestine, the vibrissæ on the snout, the distinctly annulated tail, the cleft upper lip, the moveable muffle, and the ungulate digits. To expose the viscera, the greater part of the right side of the abdomen and thorax has been removed. A red injection has been thrown into the arteries and veins. The general visceral cavity is divided by the transverse tendino-muscular diaphragm into a thorax, containing the heart and lungs, and an abdomen, in which the liver, stomach, intestines, &c. are situated. The lungs are freely suspended within a pleural cavity, and are not closely adherent to the posterior walls of the thorax, as they were in the Pigeon; the right lung is divided into three lobes, and the left into two. The heart is mesially placed between the two lungs, and its anterior surface is about equally divided between the two ventricles. The aorta is seen curving over to the left side, and from the summit of the arch the three following vessels take origin: first, the right arteria innominata which soon splits into a right subclavian and carotid arteries; a little to the left of this the left carotid arises directly from the arch; and still more to the left the left subclavian, but this is hidden from view by the left superior vena cava. On each side of the root of the neck the jugular and subclavian veins are to be seen converging; and subsequently by their union they form the right and left superior venæ cavæ. In order that these vessels might be better displayed, the thymus, or hibernating gland, has been displaced, and turned forwards over the front of the heart. Descending the neck, in close relation with the carotid artery, is the pneumogastric nerve, and a little to the outer side of the same artery the cervical portion of the sympathetic may be seen; while in close proximity with the trachea is the delicate recurrent laryngeal. Subsequently to giving off the arteries to the head and fore limbs, the aorta passes downwards through the chest just in front of the vertebral column, and gives off numerous intercostal arteries in its course: eventually it pierces the diaphragm and becomes the abdominal aorta. A little to the outer side of the thoracic aorta a rather large vein passes upwards to the left superior vena cava, receiving during it ascending course small veins from the intercostal spaces; this is the azygos vein. The phrenic nerves in their course downwards from their origins in the cervical portion of the spinal cord to their distribution in the diaphragm, of which they are the motor nerves, pass a little to the outer side of the superior vena cava, and afterwards in front of the roots of the lungs; the right phrenic nerve is in close relation with the inferior vena cava. Behind, and a little to the left of the last-mentioned vein, is the thoracic portion of the œsophagus. Beneath the concavo-convex diaphragm, and attached to it by a peritoneal process—the suspensory ligament—is the five-lobed liver. This again is rounded above and adapted by its convex upper surface to the concave inferior surface of the diaphragm, while inferiorly it more or less conceals the shrunken stomach. The stomach has a large cardiac pouch with a thin wall, and a pyloric division with much thicker and glandular walls: the œsophagus opens into it about midway between the two divisions. The epiploon, a special process of peritoneum peculiar to this class, depends from the inferior border of the stomach, and in its natural position would hang in front of the small intestines. To the left of the stomach, and attached to it by the gastro-splenic omentum, is the spleen, while below the stomach the great mass of the large and small intestines lie. Of the large intestines, the darkly stained and dilated cæcum is the most prominent, though smaller in the Rat than in most Rodentia. In the first convolution which the duodenum makes after leaving the stomach, the ramifying and diffuse pancreas lies. A black bristle has been placed beneath the hepatic duct near to its opening into the intestine at a point about an inch and a half from the stomach. On each side of the vertebral column, the slightly asymmetrically disposed kidneys are to be seen lying on the psoas muscles. Three vessels may be noticed passing out of the hilum of the right kidney; of these the anterior one is the renal artery and the posterior one the ureter, while the median and largest of the three is the renal vein. The small, buff-coloured and triangular masses attached to the anterior ends of the kidneys are the supra-renal bodies; the left one only is seen, as the right one is hidden by the hepatic lobes. Immediately below the kidney the right ovary can be seen and from it the Fallopian tube passes to the right cornu of the uterus. At a point just behind the bladder the two cornua converge to form an extremely small corpus uteri which opens into the large vagina. 'The vagina, rectum and bladder have each of them separate and independent outlets,' and into each of the three bristles have been inserted.

In the interspace between the gastric and mesenteric veins and close to the aorta from which these vessels are derived is the small, pale-coloured, semilunar ganglion: and from it two small nerves are to be observed passing obliquely upwards across the aorta to connect this ganglion with the chain of subvertebral ganglia which together constitute the sympathetic system.

The following points are to be noticed about the head in addition to those already mentioned, viz. the large submaxillary salivary glands bounding the angle of the lower jaw, and the much smaller and more diffuse parotid gland placed behind and beneath the external ear. On the right side of the animal's head and situated at a point just in front of the ear, the extra-orbital factor of the right lachrymal gland can be seen; from this portion a duct, with a slip of blue paper beneath it, passes forwards to join a second duct from the intra-orbital part which is situated at the posterior angle of the eye and inside the orbit. Near the inner and anterior angle of the eye there is another small gland about the size of a pin's head; this is the Harderian gland. Of the third eyelid, or membrana nictitans, with which this gland is always correlated, a rudiment exists and can be seen covering the anterior third of the eyeball.

A black bristle has been placed beneath one or two of the external branches of the seventh or facial nerve, as they cross the largely developed masseter muscle.

The characteristic Rodent dentition should be noted: the large, scalpriform, incisor teeth, of which there are two in each jaw, growing from persistent pulps; the absence of canines, and the large interval which separates the incisors from the molars.

The roof of the skull as well as the neural arches of the cervical vertebræ have been removed in order to expose the brain and spinal cord. The hemispheres are pear-shaped, thin, and tapering in front, but broad behind; their surfaces are smooth. In the median longitudinal fissure which separates the hemispheres, the longitudinal sinus, filled with red injection, can be seen. The olfactory lobes are very large and are altogether uncovered by any anterior extension of the hemispheres. The cerebellum has a large median and two smaller lateral lobes. In the transverse slit between the hemispheres and the cerebellum the corpora quadrigemina are partially exposed. The medulla oblongata is wide and passes behind into the spinal cord.

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